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- Driving Process Innovation in the Construction Industry -

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ABSTRACT

The construction industry is constantly accused for being inefficient, and common perceptions hold that there are room for significant improvements to the construction processes. These problems stem from, among others, the fragmented, contract-driven and complex environment of the construction industry. The state of the construction industry is not easily changed owing to the conservative nature of the industry, resulting in low long-term productivity, and an innovation level that lags behind other industries.

It is commonly recognized that changes are needed in the construction industry to alter the aforementioned challenges. To improve the project performance and overall efficiency in the industry, there has been increased attention towards process innovation tools and techniques, such as lean construction. Thus, this thesis investigates “What drives process innovation, like lean construction, in the construction industry?” An exploratory case study was performed in order to provide an in-depth understanding of the research question, by specifically focusing on the client's role and the role played by formal and informal mechanisms used to drive innovations. The data was obtained through semi-structured interviews, participation, discussions and observations.

The findings from the study demonstrate that the construction industry relies on authoritative clients taking on the primary responsibility for initiating and driving innovation. However, to successfully implement process innovations, commitment and adaptation from all industry actors are required. Making process innovation efforts a collective act by challenging the traditional mindset within contracting, is proven to facilitate innovation in the industry and should therefore be increasingly pursued. Thus, leveraging the interplay between formal and informal mechanisms in contract models and procurement processes is crucial to drive innovation. In order to develop and improve the construction industry in general, there is a fundamental need to translate the learning and innovation beyond the spheres of the project and to the organizational and industry level.
CHAPTER 1 - BACKGROUND AND MOTIVATION OF STUDY

The Norwegian construction industry has contributed to the second greatest value-creation in the country over the last decades (Regjeringen 2015). In 2014, the industry employed 230,000 and had an annual turnover of 456 billion Norwegian kroners (SSB 2016). Given the industry's crucial role in the economy, the cost efficiency, productivity and investment rates in the construction industry are of great importance. Yet, it is argued that the industry suffers from low productivity and insufficient innovation level (e.g. Håkansson and Ingemansson 2013; Fulford and Standing 2014).

This thesis strives to provide an understanding and insight of what drives process innovation that can increase the efficiency in the construction industry. Because innovation in the construction industry is regarded as highly contextual, the characteristics of the construction industry are first presented as the background to this study. This demonstrates the motivation behind this thesis. Further, the subsequent section presents the purpose of the research, the specific research questions and a description of the investigation methods. These are followed by the justification and contribution of the research question. Finally, a clarification of the scope and limitations of the research are defined at the end of this chapter.

1.1 Characteristics of the Construction Industry

Construction work involves a diverse range of actors who must be coordinated within a specific project (Harty 2005). Consequently, organizations are project based. A project-based organization (PBO) accumulates its knowledge, resources and value through projects that have a temporary lifespan. Most PBOs in the construction industry can also be considered temporary organizations within a permanent network. This means that, in addition to coordinating within a specific project, organizations have to coordinate beyond the project and with other projects and firms involved in the supply chains (Dubois and Gadde 2002a).

The temporality and uniqueness of each construction project within the permanent network result in a high degree of complexity of the industry. Gidado (1996) claims that a construction project is one of the most complex of all projects, and that the complexity is increasing due to higher requirements, greater regulations
and globalization. Further, he argues that the complexity stems from the large amount of resources involved, the nature of an unpredictable environment, the scientific knowledge required and the interactions among numerous actors involved.

Dubois and Gadde (2002a) argue that the complexity in the industry can be divided into two main categories, *uncertainty* and *interdependence*. All construction projects are unique in technical, financial and socio-political terms. Thus, they are exposed to uncertainties throughout the process. Uncertainties also originate from the volatility of the demand in the industry (Segerstedt and Olofsson 2010).

The dispersed nature of the construction industry is also problematic. Due to the extreme complexity of construction projects, clients do not have the sufficient expertise required to carry out building construction by themselves. Projects require a variety of expertise, making outsourcing and subcontracting necessary for the different specializations. This results in a highly fragmented supply chain with a high degree of interdependence among the actors (Bygballe and Goldeng 2012). This interdependence is apparent in the Norwegian construction industry in which there are approximately 75,000 companies with 97 percent employing less than 20 (Virke 2014).

On the construction site, the interdependencies among the involved actors make effective coordination among the participants necessary. Dubois and Gadde (2002a) argue that there are “tight couplings” between the actors in a specific project. In the permanent network, however, there are “loose couplings” because of the lack of significant interaction among organizations in the industry beyond individual projects. The short-term, market based exchange and culture of competitive tendering that has a strong focus on price result in a constant shift of actors across different construction projects (Bygballe and Ingemansson 2014). Such characteristics of the construction industry, however, hinder the ability to build long-term relationships and result in a “loosely coupled” system.
1.2 Motivation of Thesis

The uniqueness, complexity and temporality of construction projects, and the fragmented and loosely coupled system of the permanent network, have resulted in an industry that suffers from low levels of R&D investments and low innovation levels (Regjeringen 2015). These can be regarded as significant barriers that hamper the development of the industry. Although these related effects have been acknowledged during the last two decades, they are still considered underlying issues in the construction industry.

There is a consensus in both academia and the industry that increased productivity and growth in the innovation level is necessary. This is for example argued by Koskela (1992) and Bankvall et al. (2010) who highlight that the productivity level in the construction industry lags behind other industries. During the last decade, the Norwegian construction industry, in collaboration with powerful actors in the industry, have taken several actions to stimulate a more effective and profitable development of the industry. For example, projects, strategies and programs like Byggekostnadsprogrammet, Bygg21, BA2015 and Sammen bygger vi fremtiden (“together we are building the future”) have been established in the aim of increasing R&D investments, enhancing the innovation level and improving the level of knowledge sharing in the industry. Despite these initiatives, the Norwegian construction industry is still regarded as more conservative than other industries in the country, operating with low efficiency and low investment in R&D (Regjeringen 2015, SSB 2015). Thus, a better understanding of the possible strategies for driving innovation will potentially benefit the overall productivity and efficiency level in the construction industry.

Traditionally, innovation efforts have been initiated within the field of technology and product innovations. Over the last decade, however, these traditional innovation methods have been challenged. Innovation efforts have turned towards changing the construction processes in order to improve project performance and increase the overall efficiency of the system (Slaughter 2000). Acknowledging the lack of focus on process improvements and value creation in the construction industry, Koskela (1992) advised the industry to turn towards the manufacturing industry for inspiration where the “lean philosophy” emerged, and its implementation resulted in significant process improvements. One of the key
Objectives of lean is to differentiate between waste and value within an organization (Womack and Jones 1996). Today, the application of lean principles in the construction industry has gained attention and resulted in the emergence of the field of *lean construction*. Despite the potential benefits of this field, lean construction has not yet been widely applied (Eriksson 2010). The tools and methods of lean construction, however, increasingly impacts Norwegian construction industry. As a result, the growing attention towards lean construction offers an empirical example of process innovation in the construction industry for this study.

1.3 Problem Statement

It is commonly recognized that changes are needed in the construction industry to address the challenges of low productivity, efficiency and investment rate in R&D. Thus, this thesis considers how process innovation can help to increase the efficiency in the construction industry. With this essential goal, we offer a primary research question for further exploration:

*What drives process innovation, like lean construction, in the construction industry?*

This research question covers a host of a complex phenomena. Therefore, we find it expedient to limit the scope of research. Hence, two sub-research questions are offered to narrow the focus of the study and attempt to reach a deeper understanding of the primary research question.

Because change requires cooperation and efforts among many interdependent actors in a loosely coupled system (Dubois and Gadde 2002a), process innovation cannot be achieved by an isolated actor in the construction industry. Thus, an authoritative actor who monitors and manages the diffusion and implementation of the innovation is essential. With the client establishing the premises of the construction project, the client often inhabits such an authoritative role (Winch 1998). As a result, we consider the following sub-research question:
• What role does the client play in driving process innovation in the construction industry?

Despite the client’s ability to exert influence in the construction industry, there is an ongoing discussion regarding how to facilitate process innovation (Harty 2005). Because identifying drivers of process innovation will not capture the complexity of the phenomena, a thorough investigation of what mechanisms that affect and shape the innovation effort is necessary to reach a deeper understanding of the primary research question. Hence, the following sub-research question addresses this discourse:

• What role do formal and informal mechanisms play in driving process innovation in the construction industry?

1.4 Approach of Study

The largest public client in the Norwegian construction industry has recently pursued process innovation in one of their construction projects; the Academy of Art and Design in Bergen (KHiB). Based on the process innovation effort made in order to pursue lean construction, the KHiB-project can be regarded as a practical example of how a client uses mechanisms to drive process innovation. Thus, this thesis investigates what drives process innovation with the empirical theme of lean construction, exemplified by case study of KHiB. This enables an in-depth interrogation of the primary and supplementary sub-research questions. The case study is used as an example to provide a holistic understanding of the research area.

In the KHiB-project, the client, Statsbygg, pursued innovation with the stated goal of improving the planning and construction process of the project specifically, and in the industry more broadly. This offers the data necessary for a rich discussion of the client's role in driving innovation in the construction industry. The client required the KHiB actors to adopt the use of takt-time planning, a component of the process innovation lean construction. With this, the KHiB-project stands out as the first extensive project in the Norwegian construction industry in which lean construction principles have been implemented in both the planning and
construction phases. These specific mechanisms that the client uses to drive innovation are particularly relevant to this project. The client adopted a novel approach in the procurement process by stressing the importance of lean construction knowledge and capabilities and reducing the importance of price in the award criteria. Because the implementation of lean principles in the construction processes requires adjustment and commitment from all actors, this mechanism ensures that the suppliers are capable of reacting and adapting to the new processes in the construction. The novel procurement method was conducted by using the following award criteria in the tendering process:

- 20 % lean task understanding/experience
- 20 % reference projects and employees’ CVs
- 60 % price

1.5 Justification and Contribution to the Research Area

Our research question was developed based on our interest in the field of process improvements. We study the implementation of the process innovation, lean construction, because of the cost-competitive, complex and fragmented environment of the construction industry that thwart innovation.

In order to justify the research topic, we analyzed the study's relevance, novelty, contribution and feasibility. The research question is relevant because the problems of process improvement and decreasing innovation level in the construction industry are well-known and have in recent years been widely discussed both in media and in the industry (e.g. DN 2015, Regjeringen 2015, SSB 2015, bygg.no 2016). The approach is novel because it addresses the mechanisms used by the client in the procurement process to force and ensure, and thereby drive process innovation in construction industry. A study of the formal and informal mechanisms that accompany the process innovation lean construction is also unique. Thus, our research is novel and it contributes to the theoretical understanding of what drives process innovation. More specifically, this study emphasizes the client's role in driving innovation using formal and informal mechanisms and the industry actors’ responses and adaptations to the implementation of such mechanisms. We primarily include the perspectives of the key actors in the KHiB-project and supplement these with contributions from
independent industry experts. Taken together, this study provides a holistic view of the industry actors’ perceptions regarding the enforcement of innovation and the use of the procurement process as a mechanism for driving innovation. We hope that our findings provide a better basis for discussions of the best practices to drive and implement process innovation in the construction industry. Because we signed a formal contract with Statsbygg and they assigned us a mentor who helps us with the execution of our research, we consider the feasibility of our research to be high. Additionally, our memberships in the Lean Construction Norway association facilitate the connection to a broad network of industry experts who can provide us with different perspectives on our research.

1.6 Limitations of Research Area

Owing to the fragmented nature of the construction industry and the complex phenomena this study addresses, it was necessary to limit the area of study. Thus, our study does not provide an identification of all the drivers of innovation. Instead, it aims to understand the role of the client and the mechanisms that affect and shape the innovation efforts.

Multiple case studies of different clients’ role in driving innovation would be preferable to capture a more holistic and thorough understanding of what drives innovation in the construction industry. In addition, it would have been interesting to study multiple projects performed by the client Statsbygg, to a greater extent grasp the embedded context and further investigate how the client's efforts evolves and develops with time. However, the time and resource constraints we are bounded by limit the scope of the research to a single case study.

Our research primarily focuses on the segment of institutional and commercial buildings that is situated in both the public and private sector in the Norwegian construction industry. Our case study incorporates a collection of case interviews and additional interviews regarding the innovation efforts made in the KHiB-project. With this, our research mainly illuminates the client's ability and responsibility in driving process innovation. In other words, it limits the opportunity to provide a balanced discussion on the key influencers of process innovation in the construction industry. As a result, we direct our attention to the
mechanisms used by the client in the procurement process to compel and thereby drive process innovation. We also consider the actors’ responses and reactions to the initiatives that were employed.

Despite the limitations of this study, narrowing the scope of the study helps to reveal some interesting aspects regarding our research question in a way that would not have been possible if the scope was broader.

### 1.7 Thesis Structure

The structure of this thesis follows the motivation of the research question described in this chapter. In chapter 2, the research methodology is described and the case study and is presented. Next, the theoretical background to our study is presented in chapter 3. In chapter 4, we present an analysis of the empirical study. Chapter 5 discusses the most significant findings from the study in combination with the theoretical background. As an essential component to this, it addresses the primary and sub-research questions described in this chapter. Finally, the conclusions of our research and final remarks that offer suggestions for further research are presented in chapter 6.
CHAPTER 2 - RESEARCH METHODOLOGY

In order to answer the presented research question and sub-research questions, we offer a thorough description of the research methods and the scientific approach used in our research. The appropriateness of the qualitative research methods and use of supplementary expert interviews are also discussed. We follow this with a presentation of the methods of data collection and analytical process. Finally, the scientific quality of the study is discussed.

2.1 Scientific Approach

Traditionally, researchers distinguish between two opposite theoretical approaches to scientific research: inductivism and deductivism. A deductive approach begins with a hypothesis that is founded on an existing theory. The researcher then designs a strategy aimed at testing this hypothesis (Wilson 2010). Inductivist studies employ a reversed approach: theory is the result of the scientific research. In other words, the researcher derives generalizing inferences from his/her observations (Bryman and Bell 2011). Methods that incorporate both approaches, i.e. research and theory, are regarded as iterative (Bryman and Bell 2011). Systematic combining is a particular type of iterative approach that is positioned closer to an inductive viewpoint than deductive. It is a process method in which the theoretical framework, empirical work and analysis of the case evolve simultaneously (Dubois and Gadde 2002b). Our research into lean process innovation follows such a continuous interplay between established theory and empirical data. Thus, the systematic combining method is suitable for this study. Because it allows for the development and refinement of new theories based on the findings, this approach can contribute to the theoretical understanding of the mechanisms that drive process innovation in the construction industry.

2.2 Qualitative vs. Quantitative Research Method

Research methods can be described as quantitative or qualitative. These strategies refer to manner in which the researcher chooses to collect and analyze the information from the research subject (Bryman and Bell 2011). Quantitative research emphasizes quantification in the collection and analysis of data. Qualitative research, however, is a research strategy that typically emphasizes
words rather than quantification in the collection and analysis of data (Bryman and Bell 2011). It is also considered appropriate for reaching a contextual understanding of the data (Van Maanen 1979). Because qualitative research is often employed to understand rather than explain, it is the most appropriate strategy for our research that is aimed at understanding the variety of mechanisms that promote, drive and/or hamper process innovation in the Norwegian construction industry.

2.3 Research Design: Case Study

Yin (2014, 16) states that a case study is appropriate when an “empirical inquiry must examine a contemporary phenomenon in its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident.” Moreover, Dubois and Gadde (2002b) argues that a case study helps to develop theory by utilizing insights into empirical phenomena and their contexts. From a construction industry perspective, the likes of Kulatunga et al. (2011), Manley (2006) and Bresnen and Marshall (2000a) have successfully used the case study approach to study innovation in the construction industry, suggesting the applicability of the design in studies involving innovation in construction. Given the exploratory nature of this thesis, the case study approach was found to be appropriate, as it provides an in-depth understanding of the phenomenon of driving process innovation in the construction industry (Eisenhardt 1989).

The case study approach is increasingly applied and widely used, but is often criticized as being an insufficient scientific method compared to experiments and survey based quantitative research in terms of challenges with external validity (Eisenhardt and Graebner 2007). Yin (2014) identified lack of accuracy, being biased and apparent inability to generalize findings, as some of the common criticisms of case study research. However, case study researchers often argue that the value of the research is not dependent on the findings generalizability, but on how well the research enables generating theory from the findings (Bryman and Bell 2011). Among others, Dubois and Araujo (2007) argued that the flexibility case research provides, should not only be allowed but actively pursued and encouraged.
A primary distinction in designing case studies is between single and multiple case studies (Yin 2014). Multiple case studies are advocated to provide stronger basis for theory development (Eisenhardt 1991), while single case studies are acknowledged to richly describe the existence of a phenomenon (Siggelkow 2007). Our case study will have single case study design to exploit the opportunity to explore the significant phenomenon of what drives process innovation in the construction industry under the rare circumstances the KHiB-project provides. Additionally, the single case study will contribute to theory development on the grounds that the revelatory nature of KHiB-project makes the case worth investigating because of the descriptive information alone will be revelatory. The flexibility the single case study provides also supports the scientific approach of systematic combining (Dubois and Gadde 2002b).

Case selection

Cases are selected because they are unusually revelatory, represents extreme exemplars, or opportunities for unusual research access (Yin 2014). The KHiB case is considered suitable, in being regarded as a revelatory case.

The construction of KHiB is a suitable case study selected for this thesis. KHiB is the first extensive construction project in which the client implements and enforces work according to lean principles in the planning and construction process. Hence, this case is regarded as unique and provides the opportunity to observe and analyze a phenomenon previously inaccessible to social science (Yin 2014). The innovation effort is client-driven and the client has, for the first time, introduced lean experience/knowledge in the tendering foundation as a method for enforcing innovation in the project. Thus, the KHiB project is a suitable case to investigate the research questions in this thesis, as it properly illustrates the client's role in driving process innovation with the use of formal and informal mechanisms. As the KHiB-project is owned and performed by the industry leader and role model in the Norwegian construction industry, the findings from the research have the potential to influence the industry more broadly. Conducting a case study of the KHiB project is also considered feasible in terms of accessibility, time and resource constraints, which is a requirement stated by Miles and Huberman (1994). An intensively single case study of the KHiB-project
enables generating rich information, revealing interesting aspects and an in-depth understanding of what drives process innovation in the construction industry. In this research, the single case study will be used as an example to illustrate what drives process innovation in a broader context. Research beyond the sphere of the project studied will, thus, be used in the aim of provide the thesis with a nuanced and broader understanding of the complex phenomena.

2.4 Data Collection

Conducting a case study and study it extensively will not provide any data by itself (Bryman and Bell 2011). The researchers must also employ a suitable research method and reflect on the types of instruments or techniques that are used for data collection. The research was carried out qualitatively since results that provide detailed insight into the actors' experience and interpretation of the situation based on rich and detailed descriptions was preferred. The qualitative data collection can be divided into primary and secondary data, both by looking at external and internal sources of information (Jacobsen 2005). The data in this research was obtained both from external and internal sources. Triangulation among different types of data collection methods was performed in order to combine sources of evidence to ensure the research credibility (Yin 2014).

2.4.1 Primary Data

Primary data include data that are collected for the first time by the researcher. Examples of primary data are interviews, focus groups and first-hand observations (Jacobsen 2005). Because this research seeks to discover what drives process innovation in the construction industry, we conducted interviews with different stakeholders of the KHiB-project, since the case study of KHiB is used as our empirical example. Because the case study sheds light on the phenomenon from the perspective of only a selection of actors from a single project, the case study only presents a limited version of the reality (Bryman and Bell 2011). In order to provide breadth and depth to the study and investigate the phenomena in a broader context, additional interviews were performed with key industry participants. The additional interviews were important to gather nuanced descriptions and opinions from respondents distanced from the case. These primary data were collected from interviews and several observations, seminars and discussions, which
contributed rich and detailed answers to the analysis.

2.4.1.1 Interviews

Interviews are typically considered strong sources of evidence in case study research (Yin 2014). They allow participants to give open-ended explanations about specific topics requested by the researcher, and promote interaction that might yield additional insights (Yin 2014). Additionally, interviews are flexible, providing the researcher with the opportunity to adjust the focus of the research in order to respond to significant issues that emerge during the course of the interviews (Bryman and Bell 2011). Such flexibility is favorable to the iterative research approach in this study and can help to elicit tacit knowledge and reveal interesting and nuanced perspectives. Yin (2014, 113) identifies common weakness of interviews to be “bias, poor recall and poor or inaccurate articulation.” Thus, the ability to ask good questions is crucial in case studies. We attempted to take this shortcoming into account when conducting and analyzing the interviews.

Semi-structured interviews are preferred as they are open for adaptation for each interviewee-cluster. To enable an in-depth understanding of the situation from the different perspectives, some flexibility was necessary. Still, the semi-structured interview guide (Appendix 1) maintained an essential collection of base questions that ensured comparability among interviews. Compared to a structured interview technique, a semi-structured approach makes the study more open to new information that can steer the research in a new direction (Bryman and Bell 2011). This is in line with the iterative approach of the study.

2.4.1.2 Interviews Data Collection

Interviews with duration of approximately one hour were conducted with 17 selected interviewees. The interviewees and the respectively company positions are presented in Table 1. The semi-structured interviews were mainly conducted face-to-face, resulting in flexibility and valuable discussions.
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<td>Assistant Project Manager</td>
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<td>Anita Topdal</td>
<td>Assistant Project Manager</td>
<td>Directly</td>
</tr>
<tr>
<td>Snøhetta</td>
<td>Designer</td>
<td>Astrid Renata Van Veen</td>
<td>Project Manager</td>
<td>Directly</td>
</tr>
<tr>
<td>Rambøll</td>
<td>Consultant</td>
<td>Helge Gevelt</td>
<td>Project Coordinator</td>
<td>Directly</td>
</tr>
<tr>
<td>Veidekke</td>
<td>Contractor</td>
<td>Bjarte Hegrenæs</td>
<td>Project Manager</td>
<td>Directly</td>
</tr>
<tr>
<td>Apply TB</td>
<td>Technical contractor</td>
<td>Frode Løvneseth</td>
<td>Project Manager</td>
<td>Directly</td>
</tr>
<tr>
<td>Skanska</td>
<td>Contractor</td>
<td>Roar Fosse</td>
<td>Lean Expert</td>
<td>Not involved</td>
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<tr>
<td>Åsane Byggmesterforretning</td>
<td>Contractor</td>
<td>Frank Ståløy</td>
<td>CEO</td>
<td>Not involved</td>
</tr>
<tr>
<td>Åsane Byggmesterforretning</td>
<td>Contractor</td>
<td>Bengt Breivik</td>
<td>HMS/KS/IKT</td>
<td>Not involved</td>
</tr>
<tr>
<td>Åsane Byggmesterforretning</td>
<td>Contractor</td>
<td>Gro Mortensen</td>
<td>Project Manager/Calculations</td>
<td>Not involved</td>
</tr>
<tr>
<td>Obas Vest</td>
<td>Contractor</td>
<td>Rune Nilsen</td>
<td>CEO</td>
<td>Not involved</td>
</tr>
<tr>
<td>Obas Vest</td>
<td>Contractor</td>
<td>Øystein Slemmen</td>
<td>Project Manager</td>
<td>Not involved</td>
</tr>
<tr>
<td>Bravida</td>
<td>Technical contractor</td>
<td>Ove Kjærgård</td>
<td>Project Manager</td>
<td>Not involved</td>
</tr>
<tr>
<td>Tønsbergprosjektet</td>
<td>Contractor</td>
<td>Ingvald Grindheim</td>
<td>Expert/Project Manager</td>
<td>Not involved</td>
</tr>
</tbody>
</table>
Table 1: Presentation of interviewees

| Tønsbergprosjektet Contractor | Karl Oscar Sandvik | Expert/Lean Construction consultant | Not involved |
| Lean Construction Blog Consultant | Nawras Skhmot | Expert/consultant | Not involved |

Interview sessions were arranged with the top management of Statsbygg. The aim of these interviews was to gain insight into how Statsbygg perceived their role as a client and their responsibility in driving innovation in the construction industry.

However, the main part of the case study involved interviewing key stakeholders in the KHIB-project. To account for the client-driven process innovation of the project, we interviewed the innovation initiator, the project manager, to identify the main drivers behind the innovation efforts in this project and the rationale behind the implementation of the lean principles. Additionally, we interviewed the actors in the KHiB-project responsible for hiring the contractors. With this, we sought to reach an understanding of the challenges and successes of the contractors' adaptability and responsiveness to the innovation efforts. The consultant firm was also interviewed, because they understand the full complexity of the case but did not possess decision-making authority in the project. The designer also provided an important viewpoint because it was the first company contracted for the project. Finally, the contractors for the KHiB-project were interviewed in order for us to document their reaction to the innovation efforts and requirements set by the client in this project, their perception of their own role in driving innovation in the construction industry and their viewpoint on the lean criteria in the tendering process. The contractors had varying experiences with the lean way of working and different attitudes towards innovation embedded in the organizational culture, which provided the study with different viewpoints that enriched the research.

To complement this insider perspective, we also interviewed the rejected contractors and documented their reactions towards the innovation effort driven by the client. We investigated whether the new requirements set by the client enhanced their lean knowledge and, thus, their competitiveness in the future.
These data are augmented with interviews of experts who did not take part in the KHiB-project. These experts include actors in the construction industry who possess knowledge and opinions regarding process innovation in the industry. They are valuable because they contribute different viewpoints to the research, thereby establishing a more nuanced and enriched investigation into the broader context of process innovation.

2.4.1.3 Participation and Attendance

The researchers actively worked towards engaging the industry in order to enhance the overall understanding of the underlying mechanisms in the construction industry and the field of lean construction. For example, one of the researchers completed an internship in the KHiB-project during the summer of 2015 and gained working experience from the case company. Working closely with the project staff provided valuable insight into the practical organization of the project, the issues that clients face and the client’s perception of lean construction. The other researcher currently occupies a position as an administrative assistant in the network association Lean Construction Norway. By attending network seminars and workshops and engaging in formal and informal conversation with key industry participants, the researcher is exposed to different perspectives in the field and the current issues and hot topics related to lean construction. Such active participation provided the researchers with a basis for understanding the strategies, standards and procedures in the construction industry, thereby capturing a more comprehensive picture over the contextual setting of the case studied.

2.4.2 Secondary Data

Secondary data are data originally collected by someone other than the researcher (Bryman and Bell 2011). For this research, the secondary data are mainly internal project documents that describe the construction process in the KHiB-project and documents from the tendering process. Documents from the tendering process include the official tender documents, tender offers from the contractors and the internal tender evaluation documents used in the contracting of the contractors. These are valuable sources for the analysis of the methods which the client used in the procurement systems to compel and drive process innovation. Secondary data
were also used to analyze the prior innovation efforts made by the client and contractors, and the previous cooperation and contracts between the client and contractors. These historical data foster a broader understanding of the rationale behind the innovation initiative.

2.5 Analytical Process

This section outlines the analytical process the research is based on. This entails clarifying the development of the theoretical background, data collection and the analysis by taking into account the interdependencies between the different phases of the process.

Following our scientific approach of systematic combining, the research is based on a continuous interplay between established theory and the empirical research (Dubois and Gadde 2002b). In parallel to the data collection, the search for complementary theories was continued throughout the research process. The research processes began with a definition of the theoretical foundation by revising previous literature within the fields of innovation, procurement and lean construction. The data collection was then guided by the relevant issues and concepts drawn from the theoretical framework. During data collection, our knowledge of the case study grew, and new themes emerged that led to an adaptation and expansion of the theoretical framework and eventually resulted in a different consideration of the phenomenon itself. For example, the interplay between formal and informal mechanisms was included as an important part of the theoretical framework, partly as a result of the empirical findings, but also due to the theoretical insights gained during the research process. Other fields that emerged through this process were acknowledged to be important, but considered to go beyond the scope of our field of research and were therefore excluded. An example is the importance of “sticky knowledge” when driving innovation across levels (e.g. Szulanski 2003), which was excluded due to the broad field of this research area. Thus, the initial review of theoretical literature was broad, but further narrowed down to the most significant research areas. This is in line with systemic combing, were the evolving framework is considered to be a cornerstone (Dubois and Gadde 2002b). Thus, the analytical process, in a sense, weaves between theory and the findings from the empirical world.
The iterative process was also prevailing when collecting the empirical data, since the main findings that emerged from the interviews allowed us to identify common elements within the research area. In order to categorize the findings and capture the essence of the interviews and observations made, we started a coding process of the findings from our study as this is regarded as a key process to qualitative data analysis by several researchers (e.g. Bryman and Bell 2011; Sonenshein 2014). The coding process was primarily based on our initial interest and perception of the research area, while also allowing new themes to emerge from the interviews and observations during the data collection period. For example, the concern expressed by interviewees regarding the late involvement of contractors in the KHiB-project generated new questions to the interview guide. Additionally, as the interviewees have different backgrounds and, thus, different preconditions for answering the interview questions, it was necessary to adapt the interview guide to the interviewees. Thus, the analytical process guided a further expansion of the boundaries of the case study.

The thematic analysis conducted started with sorting the data, followed by coding, conceptualizing and categorizing as data emerged from throughout the collection process. Specifically, after weaving back and forth between existing and emergent theory as well as prior and emergent themes in the interviews, the interviews were decomposed and grouped according to analytical categories. This approach allowed us to identify the recurring categories and themes emphasized directly and indirectly by the interviewees. The overarching themes were further divided into different levels to provide an in-depth understanding of each theme. For example, we identified barriers of innovation as one of the overarching themes. The formal and informal mechanisms were derived from this theme as the following subordinate levels. For each theme, the findings from the interviews were contrasted and compared in order to capture conflicting views. Conflicting viewpoints were discussed both between the researchers and with interviewees throughout the data collection period. Thus, the conflicting viewpoints provided the study with a rich discussion. Table 2 presented below illustrates how primary data relevant for each theme was identified and classified in order to further analyze each category in the study:
<table>
<thead>
<tr>
<th>Key Theme</th>
<th>Quotes</th>
</tr>
</thead>
</table>
| Barriers of innovation in the construction industry | - “The focus on an innovative culture within this firm [Statsbygg] is insufficient. I think that this hampers the other actors’ incentives for being innovative”  
- “I think that the traditional mindset amongst construction actors is a barrier for innovation”  
- “Lack of transparency and openness is hampering the innovation level in the industry”  
- “The industry tends to be affected by silo-thinking”  
- “Lean Construction is a philosophy, which is misunderstood in the industry”                                                                                                                                                                                                 |
| The role of the client in driving process innovation | - “The client inhabits a great ability to drive process innovation and I think that they should take an active role in driving innovation in the industry”  
- “Hans Thomas Holm [project manager of KHiB] drove the process innovation in the project”  
- “Public clients has an extended responsibility to drive innovation in the industry”  
- “Innovation is dependent upon innovation champions, like Hans Thomas Holm [project manager of KHiB], in all firms in the industry”                                                                                                                                               |
| The role played by formal mechanisms in driving process innovation | - “Soft parameters in the award criteria are important to facilitate innovation”  
- “It was difficult to gain acceptance for proposed changes to the TTP”  
- “It was difficult to understand how the award criteria was evaluated by Statsbygg [the client firm]”  
- “Collaborative contracts should increasingly be used”  
- “Early involvement of all actors in a project is crucial in driving lean construction”                                                                                                                                                                                     |
| The role played by informal mechanisms in driving process innovation | - “The value of good relationships and trust is underestimated in the industry”  
- “I believe that transparency and openness in the industry is crucial for knowledge sharing”  
- “Relationships, trust and transparency is just as important as contracts”                                                                                                                                                                                                 |
| Diffusing and implementing innovation across levels | - “Driving innovations from project level to industry level is beyond my job”  
- “I don't know who should have the responsibility, but I
know that my voice will not be heard”
- “Seminars and forums are important to share knowledge and diffuse innovation above the boundaries of a project”

Table 2: Coding of findings

2.6 Scientific Quality

It is important to ensure that the research is conducted in a way that secures high scientific credibility. Bryman and Bell (2011) define reliability, replication and validity as the three most important criteria for the evaluation of business and management research. However, many scholars find it difficult to apply these concepts to the practice of qualitative research, due to its grounding in quantitative research. As a result, scholars propose alternative terms and methods for assessing qualitative research. Lincoln and Guba (1985), for instance, apply trustworthiness and authenticity for evaluating the scientific credibility of the research. These provide a better assessment of the quality of our research since they are designed for qualitative data and do not require measurement as a major preoccupation.

Trustworthiness

Trustworthiness can be divided into four different criteria, each of which has an equivalent criterion in quantitative research: credibility, transferability, dependability and conformability (Bryman and Bell 2011).

To ensure high credibility, respondent validation and triangulation techniques are applied. Triangulation entails using more than one method or source of data to study a phenomenon (Bryman and Bell 2011). As our research is based on case study interviews, expert interviews, participation and documents, triangulation increases the understanding of the complex phenomena studied, thereby strengthening the research credibility. To ensure a correspondence among the findings and perspectives of the research participants, we sought validation from different stakeholders contributing to the research.

Transferability relates to the relatability of the findings to another context or time. Although the construction industry is in a state of constant revision and our study
is highly contextual, we argue that our in-depth analysis will be valuable to others. Because KHiB is the largest project in the Norwegian construction industry in which lean principles have been implemented both in the planning and construction phase, our findings are transferable and applicable to future projects. Thus, our results provide a stronger foundation for discussions concerning the best practices that diffuse and implement process innovation in the Norwegian construction industry.

Lincoln and Guba (1985) propose the idea of *dependability* and argue that researchers should adopt an “auditing” approach to their studies. This approach requires that complete records are kept from all phases of the research process. Additionally, researchers are encouraged to use peers as auditors in order to confirm that the proper procedures are followed. Our research was closely monitored by a mentor in Statsbygg who, to some extent, held the role of auditor. In addition, the KHiB team members allowed full transparency regarding the findings, making it possible to keep complete records of the research.

*Conformability* attempts to ensure that the researcher has not allowed personal values or theoretical inclinations to sway the conduct of the research and findings (Bryman and Bell 2011). Because we collaborated with the client when conducting our research and one of the researchers held an internship at the same company during the summer, we are aware of the degree of conformability of our research. We discussed this issue with our supervisor at BI Norwegian Business School to make sure that our research is not blinded by our own perceptions. In addition, we acknowledge that all participants who we interviewed did not provide us with a completely neutral or objective view on the research, especially since the lean methodology is differentially understood in the industry in general.

*Authenticity*

Lincoln and Guba (1985) introduce *authenticity* as a set of issues that relate to the wider political impact of the research. The term comprises fairness and ontological-, educative-, catalytic- and tactical-authenticity. We claim that our research is fair because we interviewed a variety of stakeholders, both from the client and contractor side, and independent experts with different views and different perceptions of our research. Additionally, we believe that our research
has the potential to receive high educative- and ontological authenticity, by providing both the client and the contractors with a better understanding of their social milieu.
CHAPTER 3 - THEORETICAL BACKGROUND

In this chapter, previous literature related to the research is reviewed and synthesized in order to provide a theoretical background to support this study. Due to the extensive literature related to our field of research, the review is limited to the most relevant topics that address the research questions.

This chapter is divided into five sections. The first section of the theoretical background addresses the characteristics of innovation in the construction industry and the concept of process innovation. The following section discusses the client's role in driving process innovation. We also review the research concerning how to drive process innovation and present the key formal and informal mechanisms used to nurture the innovation level in the industry. Because lean construction as a process innovation is our empirical theme in this thesis, the fourth section reviews theory addressing this topic. Finally, theoretical implications are presented in the last section.

3.1 Innovation in the Construction Industry

The characteristics of the construction industry have contributed to low, long-term productivity and inefficiency in construction projects (Dubois and Gadde 2002a). At the same time, the innovation level in the industry is perceived to lag behind other industries (e.g. Seaden and Manseau 2001, Håkansson and Ingemansson 2013, Bygballe and Ingemansson 2014). In order to overcome these challenges, research addressing construction industry performance has stressed the need for improvement and innovation in the construction processes (Dulaimi et al. 2002).

The concept of “innovation” is variably understood and the definition is vigorously debated in research communities. Many professionals base their definition on Schumpeter (1934) who claims innovation to be an increase in economic growth by carrying out new combinations of knowledge, resources or equipment, and Schmookler (1952) who argues that innovation is an increase in productivity. In the construction industry, however, Slaughter’s (1998, 226) definition of innovation, based on Freeman (1989), is broadly used. She defines innovation as “the actual use of a nontrivial change and improvement in a process, product or system that is novel to the institution developing the change.”
Regardless of the various perceptions of the complex phenomenon, there is a general agreement amongst researchers that innovation is a vital component of future success (Egbu 2004).

Blayse and Manley (2004) categorize innovation as either technical or organizational. Technical innovation involves making changes in a process or a product. In contrast, organizational innovation includes changes to the organizational system and management techniques. In the construction industry, technical innovation has received more attention than organizational. Given the constant, cost-competitive environment in the construction industry, the common expectations and main focus of innovation activities are based on reducing design and construction-related costs. This is highly applicable for the technology innovation of products, which has received a lot of attention in the industry (Pries and Janszen 2001). For instance, the revolutionary designing technology Building Information Modeling (BIM) has played a crucial role in reducing the estimating and sustainability testing costs by allowing the project actors to explore and evaluate the project's constructability before and during construction (Azhar 2011).

Over the last decade, however, research indicates that innovation in the construction industry should shift towards technology innovation within the field of processes (Blayse and Manley 2004). Process innovation can be seen as the process of applying a new problem-solving idea into use, and by being able to change or adapt (Kanter 1984). In addition, Bygballe and Ingemansson (2014, 515) defines process innovation as “changes in activity links in terms of new types of production (or other) activities across firm boundaries”. Lean construction, for example, has grown in prominence to become one of the primary tools for process improvements in the industry (Sage et al. 2012). Lean construction can be defined as a process innovation because it radically changes the traditional construction process and requires collective adaptations (Winch 1998) and changes in the activity links across firm boundaries (Bygballe and Ingemansson 2014). Pries and Janszen (1995) highlight the importance of process innovation in the construction industry by recognizing that the fragmented structure of the building process and the inefficiency of knowledge sharing are the main hindrances of innovation in this context. Recently, there has been an
increased focus of innovation in construction processes and thereby the improvement of the performance of the completed facility in the desire of improving the overall efficiency of the project (Slaughter 2000). The significance of process innovation is also evident among industry participants and practitioners, and process improvement tools and techniques such as lean construction are increasingly applied (Ballard 2008). As lean construction is used as an empirical example of a process innovation in this study, theory addressing lean construction is thoroughly reviewed in section 3.4.

3.1.1 Diffusing and Implementing Process Innovation across Levels

According to Harty (2005), there is a mismatch between the high level of learning, renewal and innovation at a project level and the capture and translation of the innovation to the industry level. Industry actors are mainly concerned with their own agenda and goals, and fail to see the benefits of inter-firm collaboration and learning in the construction industry. Bygballe and Ingemansson (2014) find that there is great room for improvement in terms of learning across projects, as well as driving the new solutions to the organizational and industry level. Miozzo and Dewick (2002) further argue that actors hesitate to implement innovation due to the appurtenant risks and costs. They are, therefore, not willing to make efforts to drive innovation further than necessary. This hampers the development of an innovation from project level to succeed at an industry level. In the aim of overcoming this challenge, Harty (2005) argues that the industry actors should focus on developing the innovation from the “bounded” to the “unbounded” sphere. He defines bounded innovation as innovation restricted within a single, coherent sphere of influence and the unbounded innovation as where “the effects of implementations spill beyond this” (Harty 2005, 512). However, how to bridge the gap is a challenge.

Hence, there is a need to translate the learning and innovation from bounded to unbounded spheres in order to develop and improve the construction industry. This process is amongst researchers considered to consist of two basic steps, diffusion and implementation, and the interface of these. Robertson (1967, 14) defines diffusion of innovation as “the process by which the innovation spreads from its source of invention to its ultimate users or adopters.” Diffusion is, thus, a
special type of communication to other actors in the industry who are concerned with a new idea (Rogers 1983). In the construction industry, the pattern of the couplings is a hindrance to the diffusion of innovations because the process is complicated by the fact that innovations are implemented in a PBO and not within the individual firm (Dubois and Gadde 2002a, Miozzo and Dewick 2002). To successfully diffuse innovations, Harty (2005) states that an understanding of the unbounded innovation within the particular embedded characteristics of construction is dependent upon an approach that takes into account interactions between all industry actors. Thus, in order to successfully diffuse innovations, collaboration among the actors in a PBO has to be present, in addition to communication of the innovation's performance above the boundaries of the PBO as well as a focus on the maintenance and constant development of inter-organizational relations. These informal mechanisms are therefore of significant importance.

Once diffused, unbounded innovation must be implemented at an industry level in order to achieve success (Winch 1998). There are several barriers, however, that hinder the implementation process. Most importantly, the contract model is often a barrier for innovation efforts as there is limited room for contractors suggesting innovative solutions (Ling 2003). In addition, as earlier stated, carrying out an innovation is often costly and risky. Harty (2005) therefore argues that the most important feature for implementing unbounded innovations are the formal mechanisms. Thus, distribution of power through contracts and the existence of an authoritative actor who monitors and manages the diffusion and implementation process of an innovation are necessary in order to succeed.

As mentioned, prior research emphasizes that in order to diffuse and implement innovations in the construction industry, an authoritative innovation initiator has to be present. Thus, the next section of this chapter reviews prior research on the role of the client, in addition to other actors in the construction industry involved in driving innovation. As formal and informal mechanisms have to be carefully accounted for when diffusing and implementing innovation, the following section reviews theory concerning these mechanisms’ role in driving process innovation in the construction industry.
3.2 The Client's Role in Driving Process Innovation in the Construction Industry

Given the high complexity and the interdependency among tasks and actors in construction projects, innovations in the processes cannot be achieved by an isolated actor (Dubois and Gadde 2002a). Winch (1998) observes that construction projects are based on collaborative engagements with other organizations, making no innovation effort possible without the inclusion of the supply chain and the related network. Hence, all project actors are required to conform and adapt to any new requirements and changing work environments in order to succeed with process innovation. Thus, all project actors can be considered as key influencers of process innovation, but their ability, capacity and willingness to drive and initiate innovation is not regarded as equal by researchers. Blayse and Manley (2004) visualize the relationship among the construction participants who can influence and drive process innovation:

![Diagram of Key Influencers in a Construction Project](image)

Model 1: Key influencers in a construction project

A construction project is bounded by the influence of indirect actors, such as the regulatory framework and the technical support infrastructure that shape the context of the project (Blayse and Manley 2004). Researchers regard indirect actors as both innovation drivers and innovation barriers. When conducting a construction project, the client must follow the legislation provided by the government. These legislative measures are typically considered rigid, and, thus,
hampering the innovation potential in the construction industry. However, governmental agencies can also stimulate the innovation potential by providing considerable assistance in fostering the innovation process and learning environment, acting as a medium of industry associations, assisting in skill development and elevating requirements by means of additional legislation (Slaughter 2000; Hardie et al. 2005). Other indirect actors, like professional institutions and research communities, have the important role of “innovation brokers” who disseminate new knowledge to the industry and influence innovation (Blayse and Manley 2004; Winch 1998; Bygballe and Ingemansson 2014).

Beyond the client, the specific actors who can directly influence the innovation potential in a construction project can be assigned to five different categories: end user, designer, consultants, contractors and subcontractors (Meland 2000; Gann and Salter 2000; Blayse and Manley 2004). Consultants are considered to a varying degree foster and enhance innovation by disseminating new knowledge and expertise to the construction project (Kometa et al. 1995), while designers inhabit an influential role in the design of a building which, in turn, sets the boundaries for the construction process.

Because the client often chooses the process, procurement form and project requirements, the client to a great extent determines the boundaries for other project actors and their ability to influence innovation (Widen et al. 2008). Because the contract shapes the behavior of the designer, contractors, subcontractors and consultants, the actors’ abilities to drive innovation varies according to the specific contract model chosen by the client (Osipova and Eriksson 2011). The contractor, for instance, has a greater impact with a contract in which the contractor is in charge of the design and construction, compared to a contract in which the contractor’s main responsibility is only the assembly (Osipova and Eriksson 2011).

As prior research identifies the client as the member of the construction project who to the greatest extent can stimulate the innovation potential in order to improve the efficiency in the project (Gann and Salter 2000; Harty 2005; Manley 2006), further elaboration will be provided the client's role in driving innovation.
It could be argued that clients naturally hold an influential position in construction projects, since the client is the base around which other actors communicate, collaborate, make important decisions, and implement the project (Nam and Tatum 1997). Thus, the client possesses the ability to raise organizational expectations which, in turn, exert pressure on the other project actors’ tendency to innovate (Kulatunga et al. 2011). This is also in line with Lim and Oforis (2007), who conclude that clients, in their role of initiators in the construction process, have a direct impact on the other project actors’ decisions to innovate. Prior research has also shown that initiatives made by the client have in many cases driven project actors to meet tough challenges that required a change in the way of working (Manley 2006). By setting standards and introducing novel working conditions, the client stimulates the project actors to conform to new requirements and, thereby, promotes innovation within the permanent network. Hence, clients can have a significant impact, both in relation to their own projects and, for some, as drivers to reform and shape the context of the construction industry (Brandon and Lu 2008). However, construction clients adopt and influence innovation in the construction industry differently owing to the complex environment they are embedded in (Hartmann 2008).

3.2.1 The Clients’ Different Roles in Driving Innovation

Traditionally, general management literature has documented the role of co-production in the innovation process. Lundvall (1998) argues that most innovations are developed in collaboration with users and producers. The effect of collaboration on innovation is also evident within the literature of the construction industry. For example, Barrett and Stanley (1999) view innovation as an interactive process between the client and the project actors that focuses on empowering the client and managing the project dynamics, appropriate user involvement and team building. Regarding the level of the client's involvement in the innovation process, Sexton et al. (2008) argue that the client’s role can be located along a continuum: a dominate role, a balanced co-production role and a passive role. This visualization reflects the different roles and different configurations of the client, project team and project characteristics.
Moving beyond the degree of client involvement, Egbu (2008) identifies seven potential key roles held by the clients for driving innovation. These are based on the unique rationale from which innovation effort originates and the context in which the innovation is pursued. Egbu (2008) further argues that the different role(s) that clients can adopt must be considered within the context of the type, scale and nature of the innovation the client seeks to pursue.

1. As a source/provider of knowledge for innovation
2. Effective leadership
3. As a change agent
4. Provision of financial incentives; demanding exceptional project results, thereby prompting/fuelling innovation
5. Instituting appropriate forms of procurement and contract conditions – including value-based selection of tenders; employing performance standards and regulations
6. Improved capability in risk management (including the sharing of risks)
7. Disseminating innovations (best practice innovations diffused widely)

Given the complexity of innovation initiatives, variety of innovations and different types of construction clients, each client adopts different roles when initiating process innovation (Egbu 2008). Not all clients are equal regarding their capability to lead and initiate innovations in the construction project (Miozzo and Gil 2008). Prior research indicates that the internal innovation competence of a client has high impact on their potential to encourage innovation more broadly in the construction industry (Nam and Tatum 1997), making the client's attitude and perceptions, important factors impacting the client’s role in driving innovation (Egbu 2008). In addition, clients also need to be willing to accept the initiator role and they need to be capable to assume it (Manley 2006). Because of the variability in the client roles, it is difficult to derive a strict list of best practices for client-driven innovation.

3.2.2 Implications of Clients Driving Innovation

Although much attention has been paid to the client's potential and important role in driving and stimulating innovation, some researchers also address the corrosive
impact that clients can have on innovation in the construction industry. Ivory (2005), for instance, stresses the potentially hampering effects the client can have on innovation in the construction projects and the industry as a whole, by arguing that strong client leadership may have negative consequences for innovation, pointing towards the suppression of innovation in general and an excessively narrow focus on particular types of innovations. Green and May (2005) raise similar concerns when discussing the evolvement of lean construction, specifically. They argue that the dominant discourses within the client organizations are bound to be influenced by a discourse at a wider institutional level across the construction industry. Through the discourses, common conceptions of effective performance, innovation and client “best practices” are likely to be spread by the pressure to imitate other success regardless of whether or not such practices are suited to the “needs” of the particular client’s construction project (Green and May 2005). Similarly, Ball (1988) found that many project actors sometimes avoid the introduction of novel processes to the construction project when working for conservative clients.

In spite of a consensus in academia that the client is important and valuable in driving innovation in the construction industry, it is also important to take into account that the client may be limited by its own perceptions and capabilities. Thus, it is beneficial for the client to take on a holistic view when pursuing process innovation and also consider how the specific context influences innovation initiatives (Brandon and Lu 2008).

### 3.3 Key Mechanisms of Driving Process Innovation in the Construction Industry

To capture the expected benefits of an innovation, the innovation initiator needs to understand the means through which innovation are implemented and the strategies it can employ to increase the effectiveness of the construction process (Slaughter 2000). As the scope, nature and the degree of innovation efforts are different from every unique construction project, there is no unilaterally best practice of how to effectively drive process innovation (Egbu 2008). However, previous literature argues that in order to diffuse and implement innovations from project level to industry level, there is a need for facilitating and develop the
formal and informal mechanisms to order to support the implementation of unbounded innovations (e.g. Ling 2003; Harty 2005; Cicmil and Marshall 2005). Due to the nature of process innovation and the subsequent requirements, the following review of previous literature will be divided into formal and informal categories in the aim of studying how to successfully diffuse and implement process innovation from a client's stance.

### 3.3.1 Formal Mechanisms

It is apparent that the industry is biased towards the role played by formal mechanisms like organizational structures, co-locations and procurement systems in developing collaborative relationship. Appropriate tools and techniques that can bring changes in motivations and behavior amongst industry participants are regarded as essential in culture transformation (Bresnen and Marshall 2002). Thus, concrete tools and methods are required to engineer and stimulate innovation and change (Bresnen and Marshall 2000a). de Valence (2010) claims that methods, laws and tools must be developed and applied to project based systems in order to make innovation a collective act, and therefore that the best way to nurture innovation within the construction industry lies in the procurement methods and systems. He further argues that the formal mechanisms are the most important feature for implementing innovations at an industry level. More specifically, the use of contract and the procurement process can be argued to be essential for improving the industry (Harty 2005). This is in line with Dubois and Gadde (2000) who claim that it is the purchasing behavior that determines the level of innovation in an industry, as the procurement processes sets the premises of the working environment by enabling and constraining the potential of the project actors. Furthermore, van Weele (2014) and Masterman (2003) argues that the procurement methods are crucial for innovation and change, as the structure of project procurement allocates the risks and responsibilities in the construction project.

Procurement is “the amalgam of activities undertaken by a client to obtain a building” (Franks 1984, cited in Kumaraswamy and Dissanayaka 1998, 225), and involves the “acquisition of project resources for the realization of a constructed facility” (Lu et al. 2011, 4). There has been a recognized shift in the role of
procurement, from being a traditional administrative role, to gaining strategic importance for a company that involves strategic alliances, collaborative relationships and supply chain management (van Weele 2014). Due to the importance of procurement, the next section will reveal how the procurement process can be used to promote or prevent innovation in the construction industry. The first subsection discusses how the chosen contract model affects the client's ability to promote or prevent innovation. The second subsection demonstrates how the client's procurement procedures promote or prevent innovation.

3.3.1.1 Contract Model

The scope of procurement for a construction project is broad and involves the organization of a myriad of actors for the design, management and construction of a new facility (Rashid et al. 2006). Purchased services and materials account for up to 90 percent of the total project costs for the client (Kumaraswamy et al. 2000). This makes the contracting process a highly important strategic decision for the client. Larson and Gray (2014, 450) define a contract as “a formal agreement between two parties where the contractor obliges itself to perform a service and the client obliges itself to do something in return, usually in the form of a payment to the contractor.” The contract should outline the specific terms of the transactional obligations of the parties involved and provide for all possible contingencies. Contracts have a significant impact on project success because it shapes the behavior of the actors involved and their ability to facilitate innovation.

Process innovation is enhanced by a suitable environment created by the client. Thus, the organizational structure of the project has a large impact on the innovation possibilities in the construction project (Turner 2003). In the Nordic construction industry, there are mainly two project delivery methods used, namely design-bid-build (DBB) contracts and design & build (DB) contracts (Osipova and Eriksson 2011).

In a DBB contract, the client is responsible for design, planning and function, while the contractor is solely responsible for assembly. The DBB contract can hamper innovation because contractors cannot affect the design phase (Eriksson and Westerberg 2011). Additionally, the lack of communication and joint
problem-solving efforts among project members prevents innovation (Korczynski 1996). The contractors' proposed amendments to the contract may also have difficulty gaining acceptance because the client drives the process.

In a DB contract, however, the contractor is responsible for both design and assembly. Thus, the contractor carries a greater ability and responsibility for influencing innovation (Osipova and Eriksson 2011). Clients tend to favor DB contracts because the contractor is responsible for design and then carries more of the risk. Thus, this contract model has increased in popularity in recent years. Previous research also demonstrates that DB contracts result in a greater speed of execution and lower total project costs than DBB contracts. On the other hand, DB contracts can be more expensive for the client than the alternative DBB because fewer contractors may be able to provide such extensive and comprehensive work (Osipova and Eriksson 2011). When it comes to introducing innovations, a DB procurement system is favored when the innovation efforts come from the contractor or subcontractor. The model facilitates solutions with a high constructability, and a focus of reducing risks and improving profits can result in innovative solutions (Tam 2000; Blayse and Manley 2004). However, as the theory encourages the client to act as the innovation driver, a DB contract might hamper the client’s ability to drive innovation.

It has been suggested that a mix between the two contract types might raise the innovation level in the construction industry (Eriksson and Westerberg 2011). Early involvement of the contractor in the design phase improves the quality of the project and reduces the risks. Dulaimi et al. (2002) argue that this design of a contract model promotes innovation in the industry due to the high expected goals, the strong commitment of all actors involved and the joint participation of innovation efforts.

3.3.1.2 The Procurement Procedure

The constellation of actors in the construction industry is constantly changing, and it has been argued that public tendering procedures and public procurement regulations are dominant factors that result in short-term and adversarial relationships. In addition, the short-term market based exchange and culture of competitive tendering with a strong focus on price result in a constant shift of
actors across different construction projects (Bygballe and Ingemansson 2014). Such short-term relationships hamper the learning process from one project to another and impede continuous improvement and innovation in the industry (Dubois and Gadde 2002a).

As a result, the type of tender procedure used by the client can affect innovation in the construction project. An open (one-stage) tender procedure can result in increased competition among the contractors, which to some extent can facilitate innovative solutions. A restricted (two-stage) tender procedure can result in fewer contractors placing a bid. The client can set qualification criteria which only preferred contractors can fulfill. This fosters the establishment of long-term relationships and learning that might promote innovation (Laerde 2006; Eriksson and Westerberg 2011). However, as the contractors normally have difficulty getting approval for innovative solutions with their offers, the tendering process does not facilitate innovation unless the innovation initiative is driven by the client.

In order to achieve the best possible construction project in terms of price, quality and time, the selection process of the contractors is vital as the involved suppliers account for a large share of total project costs for the client (Kumaraswamy et al. 2000; Eriksson et al. 2008). Thus, the bid evaluation process is highly important for project performance (Kumaraswamy and Anvuur 2008). Choice of contractor is traditionally conducted by using a price-based selection with a lower focus on soft parameters in the award criteria, especially for public clients (Eriksson et al. 2008). Holt et al. (1995), however, argues that the client should focus on finding the best contractor in terms of value for money rather than the contractor with the lowest bid. Broadening the evaluation of tenders by including soft parameters such as earlier experience, collaborative skills, reference projects, and innovative solutions or requirements will have the possibility of improving the overall project performance (Manley 2008; Eriksson and Westerberg 2011). As a result, there is a growing interest in shifting from bid evaluations based solely on lowest price to include soft parameters in the award criteria as well (Caldwell et al. 2009). In spite this shift in interest, price remains a dominant parameter in the public construction industry (Kumaraswamy and Anvuur 2008).
Several researchers have also identified the terms of payment as an essential aspect of the procurement process (Turner 2003; von Branconi and Loch 2004; Osipova and Eriksson 2011; Larson and Gray 2014), as the payment form defines the degree to which the client monitors the results or outcomes produced by the contractors (Eriksson 2013). The three most common payment contracts in the construction industry are fixed-price contracts, cost-plus contracts and mixed-incentive contracts. In a fixed-price contract, also called a lump sum contract, the contractor agrees to perform all the work described in a contract at a pre-set fixed price (Larson and Gray 2014). This is the most commonly used type of payment in the construction industry. In a cost-plus contract, the contractor is reimbursed for all justified costs plus an additional fee to cover overhead and profit. The fee is negotiated in advance and includes a percentage of the total project costs. Mixed-incentive contracts have fixed-price and cost-plus portions with a focus on a shared target. Incentive fees, bonuses, penalties and target prices are included to compel the contractor to minimize costs without reducing the quality of the project (von Branconi and Loch 2004). This type of payment is rarely used because it is considered difficult to realize in practice.

Blayse and Manley (2004) agree with Walker and Hampson (2008) claiming that a fixed-price contract is the most detrimental contract type to innovation in a construction project. This type of payment involves the highest risk for the contractors, promotes adversarial relationships and yields poor innovation outcomes. In contrast, the mixed-incentive contract is considered by several researchers as the best contract in terms of innovation, as this type of payment increases the actors’ motivation to perform optimally and develop innovative solutions (Dulaimi et al. 2002; Blayse and Manley 2004; Eriksson and Westerberg 2011).

3.3.1.1 Barriers of Formal Mechanisms

Formal mechanisms that encourage the development of an appropriate culture of change and establishment of strong relationships within the project are essential for diffusing knowledge and implementing innovations in the industry (e.g. Bresnen and Marshall 2002). However, specific formal mechanisms such as the cost competitive procurement process, the allocation of risks in the industry and
the rules of public procurement also serve barriers to the implementation of innovations. Consequently, researchers have in recent years emphasized the role of informal mechanisms for driving innovations. As a result, they propose more collaborative contract models and tendering processes that include a number of soft parameters. Such informal mechanisms can be used for facilitating and fostering innovations and should therefore also be accounted for.

3.3.2 Informal Mechanisms

Poppo and Zenger (2002) describe informal mechanisms as rules based on implicit understandings that are socially derived. The informal mechanisms are shaped by soft factors that promote norms of trust, solidarity, flexibility and information exchange. Informal mechanisms to design cooperation for innovation which are not based on contractual agreements play an important role in driving and diffusing innovation in the industry (Bönte and Keilbach 2005). This is in line with Harty (2005) who state that the informal mechanisms such as collaboration, communication, and long-term relationships are crucial for a successful diffusion of innovations.

Process innovation is a complex, dynamic and long process, which involves actors from within and between organizations to conform collectively to changed standards and requirements (Saad et al. 2002). Because process innovation is dependent on a high level of coordination and integration, researchers stress the need for the development of more effective and cooperative relationships among the project participants (Spekman et al. 1998). This viewpoint is supported by Dubois and Gadde (2002a) who state that tighter relationships also between and among firms beyond individual construction projects can enhance the conditions for innovation. Hence, a focus on tightening the relationships within the temporary organizations and among the actors in the permanent network is regarded as important for clients driving innovation in the construction industry. According to Hellard (1995) some of the key informal mechanisms for establishing and developing collaborative relationships are commitment, mutual objectives, trust, communication, continuous learning and knowledge sharing.
Commitment among all project actors is considered to be a prerequisite for succeeding with process innovation (Walker 2002; Rutten et al. 2014). Ensuring commitment is therefore a critical but challenging component in driving innovation, due to the fact that innovation initiatives are often met with resistance that results from a fear of behavioral change and risk-increase. Thus, it is important to devote time and resources to prepare the operational body of each project organization in order to minimize the adoption barriers when implementing changes to the construction process and working towards tightening the bonds among the actors (Hartmann 2008). Moreover, top management commitment is considered as an essential precondition for succeeding and developing innovations, whether the initiatives originates bottom-up or top-down in the organization (Nam and Tatum 1997; Cheung 2015). On a similar note, Egbu et al. (1998) states that an environment promoting top-down, bottom-up and lateral communication fosters and facilitates innovation.

Slaughter and Cate (2008) also stresses the importance of the innovation initiator to establish and communicate the superordinate goals and objectives that bind the project actors together in order to enable and develop the commitment and collaborative relationships upon which process innovation relies on. In addition to effectively communicating the goals and motivation behind the innovation initiative, researchers also emphasize the importance of informal communication, learning and knowledge sharing among project actors as key drivers for building tighter relationships on the project level (Dulaimi et al. 2002). For instance, team building activities and project-wide communication in the early phases of the construction project is considered to positively influence actors´ behavior and enhance their general knowledge of the project (Kadefors 2004). Additionally, Bygballe and Ingmanson (2014) regard sharing experiences and knowledge amongst actors as essential in fostering innovation in the construction industry. Most reviews of innovation in the construction industry have also identified the need to facilitate a culture that promotes innovation and trust as a critical for tightening the bonds among the actors in the industry (e.g. Fulford and Standing 2014). Among other, Kadefors (2004) argues that higher levels of trust among actors enhances project performance and improves project relationships, because if trust is present, actors can interact and collaborate without elaborating on what hidden motives exchange partners might have and on the risks of disclosing...
information. Furthermore, it is agreed upon that the more coordination and collaboration there are between project actors, the greater the potential for succeeding with innovation will be (Blayse and Manley 2004; Roy et al. 2004).

### 3.3.2.1 Barriers of Informal Mechanisms

As illustrated by previous literature, collaborative engagements with other firms are required for the implementation of innovations because most construction projects operate in a tightly coupled system. In order to succeed, all project participants must be committed and work collectively towards conforming to the new process requirements. Numerous papers have discussed how informal mechanisms like integration, trust and closer relationships can solve the inefficiency problem and the problem of low innovation level in the industry. However, the construction industry still fails to see these as significant advantages as it is viewed as challenging to build and maintain informal mechanisms like trust and commitment amongst project actors. Some researchers question if these mechanisms can be developed fully and preserved in the context of exchange relationships that are characterized by uneven distributions of power, economics and risk (Bresnen and Marshall 2000b).

### 3.3.3 Interplay between Formal and Informal Mechanisms

Previous literature typically treats formal and informal mechanisms independently from each other. Consequently, there lacks a sufficient exploration of the interplay between these mechanisms (Poppo and Zenger 2002). Recent research, however, has concluded that both formal and informal mechanisms have the ability to shape the project actors’ behavior by enabling and constraining their potential conduct, and thereby that the interplay of these mechanisms affects the innovation potential in the PBO and the industry in general (Larson 1992; Zaheer and Venkatraman 1995; Bygballe et al. 2015).

As the client and the project actors have to collaborate when conducting a project, the use of collaborative tools has received more attention in recent years due to its potential for improving project performance. An example of a collaborative tool that has received much attention in the industry and in academia is partnering agreements (e.g. Matthews et al. 2000; Agapiou et al. 1998; Forbes and Ahmed
2011). Construction Industry Institute (CII 1991, iv) defines partnering as “a long-term commitment by two or more organizations for the purpose of achieving specific business objectives by maximizing the effectiveness of each participant’s resources. This requires changing traditional relationships to a shared culture without regard to organization boundaries. The relationship is based upon trust, dedication to common goals, and an understanding of each other’s individual expectations and values. Expected benefits include improved efficiency and cost-effectiveness, increased opportunity for innovation, and the continuous improvement of quality products and services.” However, because many projects are initiated by public clients that are bounded by the laws of public procurement, long-term partnering agreements are challenging in such circumstances (Bygballe et al. 2010). Thus, the literature is mainly concerned with partnering at a project level, which will not foster long-term relationships and thereby innovation in the industry.

In addition to the above mentioned collaborative tool, innovative contract models used as tools to improve the collaboration in construction projects have received much attention in recent years. Examples of these contract models are Project Alliancing (e.g. Sakal 2005), Public Private Partnerships (PPP) (e.g. Akintoye et al. 2011) and Integrated Project Delivery (IPD) (e.g. The American Institute of Architects 2007). These delivery methods are based on relational contracting principles, meaning a simultaneous use of formal contracts and informal mechanisms to govern the relationships between the actors (Bygballe et al. 2015). As these contract models require more cooperation among the actors involved, the innovation efforts made are considered to be easier to implement than when using traditional contract models (Wang 2015).

It is generally agreed that the interplay between formal and informal mechanisms in the PBO will have an impact on the outcome of implementing process innovation in a construction project. However, researchers view the relationship between the formal and informal mechanisms differently (Caldwell et al. 2009). Some argue that formal and informal mechanisms to some extent can substitute each other, by for instance recognizing trust as a substitute for a complex contract (Granovetter 1985; Dyer and Singh 1998), while others oppose this view and considers informal mechanisms like trust and contracts as inter-related in differing
dynamic patterns (e.g. Caldwell et al. 2009; Poppo and Zenger 2002). The complex interplay between these mechanisms can be seen at different levels when pursuing and facilitating innovation. As already stated, the formal mechanisms such as the contract model and the procurement systems determine the structural settings for the construction project. Consequently, the chosen procurement process will have an impact on the fit between formal and informal mechanisms during the construction project making the interplay a significant factor to take into consideration when procuring (Wang 2015). As a result, when shaping the procurement system, the effect of the informal mechanisms is increasingly recognized and accounted for.

Thus, the interplay between the formal and informal mechanisms affects the success of the innovation efforts initiated in the construction industry when pursuing and facilitating for process innovation. Because this study investigates what drives process innovation with the empirical theme of lean construction, it is necessary to study how the interplay are expressed in the field of this empirical theme as this has not been extensively explored in existing research. In order to establish a basis for further empirical study, fundamental theories concerned with the field of lean and lean construction are reviewed in the next section. Combining existing theory in order to investigate how to diffuse and implement lean construction can help shed light on this field of study.

### 3.4 Lean Construction as a Process Innovation

Because lean as a process innovation serves as the empirical approach in this thesis, the following section reviews the theoretical background to lean and lean construction. The implementation of principles from the lean philosophy in the construction processes can be viewed as process innovation because it entails radically changing the construction process and the interdependencies among the actors in the PBO (Bygballe and Ingemansson 2014). As one of most important aspects of lean is involvement of all project actors, introducing lean principles to the construction project will not solely affect the innovation initiator, but require adjustments from all actors (Winch 1998). In addition, applying lean principles will also to a great extent change the need for interaction and collaboration between the involved project actors. When driving process innovations, like lean
construction, it is important to account for both formal and informal mechanisms, as well as the interplay between these in order to ensure collective adaption and commitment. Thus, studying the implementation of lean construction is a relevant and valuable example when seeking to understand what drives process innovation in the construction industry.

3.4.1 The Lean Methodology

Scholars have found it challenging to agree on a single definition for the term lean, partly due to the myriad of various definitions and understandings that exist, but mainly due to the fact that lean is a continuously developing philosophy and its application differs for every situation. However, one of the most commonly cited definitions is given by Shah and Ward (2007) who define lean production as “an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability.” The automaker Toyota is credited as the founder of lean production with its Toyota Production System (TPS) (Shingo 1989).

One of the key objectives of lean is to differentiate between waste (muda) and value within an organization. Womack and Jones (1996, 15) define waste as “any human activity which absorbs resources but creates no value” and value as “a capability provided to a customer at the right time at an appropriate price, as defined in each case by the customer.” They propose the five following principles for guiding the implementation of lean, which is commonly considered as the original lean principles:

1. Specify value—specify what creates value from the customer’s perspective
2. Identify the value stream—identify all the steps along the process chain
3. Flow—make the value process flow
4. Pull—make only what the customer needs
5. Perfection—strive for perfection by continually attempting to produce exactly what the customer needs. This process is called continuous improvement (kaizen)
Other principles derived from the methodology have also been adopted. But, in general, the application of lean principles in an organization involves continuously working towards identifying and eliminating waste from processes in the aim of leaving only value added activities in the value stream (Rother and Shook 1999).

3.4.2 Lean Construction

Lean as a concept has evolved beyond lean production and continues to develop and influence other areas of business. In the construction industry, waste is considered a characteristic of the supply chains and a hindrance to supply chain performance (Arbulu and Tommelein 2002). In order to trim production and generate the maximum amount of value, there is a need for improved efficiency and fundamental innovation changes in the construction process. In 1992, Koskela argued that there was a lack of focus on process improvements and value creation in the construction industry, and he suggested that the industry should look towards the lean philosophy for inspiration. Today, the term lean construction is considered to be the application of lean manufacturing principles in the context of the construction industry and has grown in prominence to become one of the primary “process improvement recipes” in the industry (Sage et al. 2012). The most commonly used definition was proposed by Ballard and Howell (1998) who define lean construction as “handling a construction project as a temporary production system while delivering the product with maximum value and minimum of waste.” The perceived objectives of lean construction extend from a lean production system – maximize value and minimize waste – to specific techniques and tools for application in a new project delivery process.

3.4.3 The Tools of Lean Construction

Acknowledging that the production system and the project management needs to be structured and based on different techniques than traditional projects, new tools, techniques and frameworks have emerged from lean construction and influenced the industry. From lean construction, a set of tools and techniques such as the Last Planner System (Ballard and Howell 2003), Lean Project Delivery System (Ballard 2008), Just-In-Time (JIT) delivery, value-stream mapping (Arbulu et al. 2003), VDC (virtual design and construction) and BIM (building information modelling), takt-time planning (TTP), and target value design
(Ballard 2011) has emerged to improve the efficiency in the construction projects. These tools are typical for lean construction projects and have their basis in the original lean principles, but are designed and customized to the context of the construction industry. The Last Planner System (LPS), for instance, is one of the tools that has the most significant impact on the practitioners in the industry, while takt-time planning (TTP) has had an increasing impact on the Norwegian construction industry. The tools and techniques from lean construction is increasingly applied in the construction industry in the aim of achieving process improvement.

**The Last Planner System**

The Last Planner System (LPS) was developed by Glenn Ballard and Greg Howell in 2002. It is defined by the Lean Construction Institute as a “production planning system designed to produce predictable work flow and rapid learning in programming, design, construction and commissioning of projects” (Lean Construction Institute 2016). LPS aims to achieve the lean objectives of decreasing waste, increasing productivity and decreasing variability primarily through a social process, by making planning a collaborative effort and by improving the reliability of the commitments of the project actors (Ballard 2009). The collaborative phase scheduling process of LPS promotes participation and early involvement, thereby increasing the level of commitment between the various actors around the production plan.

**Takt-Time Planning**

Takt-time planning (TTP) is a scheduling technique that focuses on separating the construction project into individual work locations (takt areas). Each takt area houses a number of tasks which require similar quantities of work and duration for each task, without operating with buffers (Linnik et al. 2013). The aim is to make the workflow continuously by optimizing the pace (takt) of the production, thus reducing the waste in the production system and create transparency and stability in construction process.

TTP is similar to the LPS in the sense that both techniques require collective adaption and commitment from all project actors. The TTP technique, however, has been criticized by some as suitable only for projects that include a high degree
of repetitive work. Despite this, other studies conclude that TTP may also be appropriate for projects with the majority of work being non-repetitive (Linnik et al. 2013). Because the implementation of TTP in construction projects is relatively novel, research and discussion on these topics are still ongoing in the lean construction community (Seppänen et al. 2010).

3.4.4 Diffusion and Implementation of Lean Construction

Implementing principles, tools and techniques from lean construction involves radically changing the construction process. Lean projects not only differ from traditional projects in the goals it pursues, but also in the structure and definition of phases, the relationship between phases and the participants in each phase (Ballard and Howell 2003). Increased collaboration and interaction among project actors are considered prerequisites for succeeding with lean construction (Eriksson 2010). Hence, the application of innovative tools from lean construction to the construction project in order to maximize the value generation is dependent on collective adaption to the changed requirements and working methods from all actors in the industry.

Thus, process innovation through implementation of principles and strategies drawn from the field of lean construction entails radical changes in the project setting for the production system, making implementation issues highly recognized. Mossman (2009) argues that the principles of lean construction must be accompanied by a consistent strategy for implementation and be praised by the top management in order to ensure the success of the implementation. Sage et al. (2012) take it further, stating that a lean organization requires every actor to be involved and actively participate in the collaborative activities on which the lean tools and techniques are founded. This is in line with common perceptions among researchers that lean construction implementation begins with leadership commitment and is sustained by a culture of continuous improvement (Aziz and Hafez 2013), and therefore lack of top management commitment towards pursuing lean process innovation serve as a barrier for successful diffusion and implementation of lean construction in the industry.
The conceptual vagueness surrounding lean construction is also seen to complicate the diffusion and implementation process. Because lean construction is multi-faceted, it is difficult for many to unambiguously define what it means and fully understand the implications of implementing it (Pettersen 2009). In addition to the terminological confusion, lean construction is also conceptualized and understood differently by various industry participants. Green and May (2005) even argue that the meaning of lean construction “is continuously renegotiated within localized contexts.” As a result, we explore the various applications of the concepts of lean in the construction industry in this section.

Prior literature related to lean construction can be divided into three broad categories: strategic, operational and tactical subjects with much of the research conducted in the latter category. When lean construction is viewed from a tactical perspective, it regards the issues of the current construction process by focusing on the tools and techniques that are based upon improving the off-site assembly (Garnett et al. 1998). According to Herrala et al.’s (2012) study, researchers and industry participants seems to mainly focus their attention to the operational perspective of lean construction, neglecting the philosophical and strategic perspectives. Lean construction from an operational perspective entails implementing a set of tools and techniques in the aim of eliminating waste from the construction process (Liker 2004, Shah and Ward 2007). Herrala et al. (2012) argues that this illustrates the relative ease of implementing lean as a set of tools that improve the current ways of working and the difficulty of seeing it as a value creation process.

At the industry level, lean construction is also frequently considered a viable strategy for implementation. As a result, researchers are increasingly looking to understand the effects of lean strategizing in these broader construction contexts. This trend is evident with Sage et al.’s (2012) study of lean construction from a strategy-as-practice (SaP) perspective.

3.5 Theoretical Framework

The review of the theoretical background constitutes the basis for the discussion of the research question which covers what drives process innovations,
exemplified by lean construction, in the construction industry. A joint consideration of these areas makes up the theoretical implications of our research. Because no independent field of research covers all the underlying propositions of our study, theories from a number of research areas have been considered. By extracting the fundamental qualities of each perspective and implementing these into our empirical context, we have established an academic basis for our study. Therefore, the synthesis of these different perspectives provides a novel and valuable evaluation of process innovation in the construction industry. We believe that our theoretical review can shed light on the client's potential to drive process innovation, and on how the formal and informal mechanisms and the interplay between these can be used to drive process innovation in the construction industry.

Since the focus on process improvement in the industry, exemplified in our study by lean construction, is increasingly put on the agenda, a wider perspective on the implications of driving this form of innovation is needed. Based on the preceding review, a theoretical framework has been developed that serves as a basis for our empirical study and discussion of findings. The outline of our theoretical framework is presented in Figure 1:

![Theoretical Framework](image)

Figure 1: *Theoretical Framework*

The temporality and the uniqueness of each project and the complexity involved with the number of actors in each project, are significant characteristics of the construction industry. Dubois and Gadde (2002a) assert that these characteristics of the construction industry result in a fragmented supply chain with several
interdependencies. This leads to uncertainties and difficulties implementing innovations in the industry. A brief description of the key implications based on the findings from the theoretical background follows.

Prior research identifies the client as the industry actor who, to the greatest extent, can stimulate the innovation potential in the industry and improve the overall efficiency of the project (Gann and Salter 2000; Manley 2006; Harty 2005). Numerous papers have concluded that both formal and informal mechanisms can shape the project actors’ behavior by enabling and constraining potential conduct. As a result, the implementation of these mechanisms affects the innovation potential in the PBO and the industry in general (Zaheer and Venkatraman 1995; Bresnen and Marshall 2000a; Bygballe et al. 2015). The interplay between these mechanisms, however, has not been sufficiently explored and understood together by previous research. An interesting and novel research angulation emerge in the combination and interfaces of these findings. Thus, further investigation will cover how the client can drive process innovation, such as lean construction, by setting standards and novel requirements in the procurement process.
CHAPTER 4 - EMPIRICAL FINDINGS AND ANALYSIS

We performed an exploratory case study in order to provide a deeper understanding of the research question, “What drives process innovation, like lean construction, in the construction industry?” The structure of this chapter follows the dominant themes that emerged from the data collection and analysis, and it is based on the theoretical framework presented in chapter 3. The topics are intended to not only share the insights of the case study, but it also allows for a deeper and holistic understanding of the industry more broadly.

This chapter presents a combination of the empirical findings and analysis, and is organized with five sections. The first section offers the empirical findings of the innovation level in the Norwegian construction industry and the challenges associated with implementing innovations. The second section introduces the case study by evaluating how to drive process innovation, particularly lean construction, in the KHiB-project. This is followed by a detailed description of the empirical findings and analysis of the research questions. Our analysis in this section focuses on the role of the client and the specific mechanisms that drive innovations, and the interplay between these. Findings from these considerations are then synthesized to provide an overall analysis of the research question in section four. We present a final summary of the empirical findings in the fifth section.

4.1 Innovation in the Norwegian Construction Industry

It is acknowledged by all interviewees that the innovation level in the Norwegian construction industry is not sufficient, and that there is a need for improvement and change in the construction processes. Several interviewees stress that the productivity level in construction projects has declined in the last decades due to a variety of factors, including new environmental requirements, accelerating reporting requirements and higher technical standards that complicate the construction processes. Thus, many actors perceive the construction industry’s increased complexity and bureaucracy over the last 20 years to be a detriment to the overall productivity. Fewer hours are spent on construction, and more working hours are devoted to documenting and solving technical challenges. Additionally, the industry has become more fragmented in terms of mergers of firms into a few
large companies in addition to the existence of a myriad of small companies, which increases the complexity of the constellation of actors.

The industry is also characterized as conservative in the sense that the actors often “thrive in old habits,” and that efforts made by industry actors to change and improve the way of working are viewed as limited. Another related attitude often stressed by interviewees is that, because construction projects are unique, there lacks a significant focus on knowledge sharing from one project to the next project. This results in “silo thinking” in individual construction projects and across construction companies. Altogether, the efforts that have been made to learn from project successes and failures are insufficient.

Additionally, findings show that there is a minority of highly-educated workers in the construction industry. This absence is perceived as an explanation for the failure to adopt into practice methods that have emerged from academia. Also, few construction workers look to the research conducted within the construction industry in order to increase their knowledge and advance their competence.

Although there is a consensus that the innovation and productivity levels are too low in the industry, most actors highlight the cost and high resources required for innovation. Interviewees describe the construction industry as contract driven, because contractors traditionally compete for the lowest price in order to get contracted. In an industry characterized by low margins and a high cost structure, absorbing excessive costs without documented benefits is considered a risky endeavor. The potential for innovation to be included in the offer during the procurement process is, therefore, limited.

Our findings reveal that interviewees perceive the Norwegian construction industry to suffer from a low innovation level because of an insufficient focus on the pursuit of innovation. It is acknowledged by industry participants that changes need to be made in the construction processes and thereby implement process innovations. The case provided interesting findings of how the client used formal and informal mechanisms to drive innovation in a project.
4.2 Introduction of Case Study

The aim of the KHiB-project is to construct a new Academy of Art and Design in Bergen in order to expand the education opportunities within this field in Norway. The budget of the project is 1038 million Norwegian kroners, and completion is expected in the first half of 2017 (Statsbygg 2014).

In Statsbygg’s mandate, it is stated that as an industry leader, Statsbygg has a social responsibility to foster innovation and contribute to the development of the Norwegian construction industry (Statsbygg 2014). Based on this, the internal project manager of the KHiB-project was motivated to improve the planning and construction process. By coincidence, the project manager came across a consultant from Porsche Consulting who introduced lean construction and takt-time planning (TTP). Convinced by the potential benefits of lean construction, the KHiB project manager endeavored to employ TTP in his next construction project. The introduction of lean construction was thus not initiated by the top management of Statsbygg, but championed by the project manager.

In the planning phase of the project, the lean philosophy was set to permeate the project from beginning to end as illustrated in Model 2. More specifically, the lean construction method TTP was initiated as the main lean construction tool in the project.
Model 2: **KHiB project plan**

Because lean construction and TTP require a detailed planning process and close collaboration among all involved actors, Statsbygg established the collaboration phases A, B and C in the project: contracting (A), description and design (B) and collaboration and planning (C). In order to achieve full control over the complex project, the management team of KHiB planned 80 percent of the construction work prior to the contracting of contractors. In phase C, the contractors were involved in the planning of KHiB.

The management team of KHiB includes internal resources from the client organization Statsbygg. The assistant manager of the project phase was contracted from Atkins to assist with detail planning. The planning manager from Atkins was also included in the internal project team within Statsbygg. Additionally, Snøhetta was contracted as the designer and Rambøll serve as the engineering consultant. The management team of KHiB is illustrated in Model 3:

![Model 3: KHiB management team](image)

Model 3: **KHiB management team**

4.2.1 *The Supplier Selection Process in KHiB*

Because the implementation of lean construction and TTP in all phases of the construction project both increases the level of interdependence among actors and requires collective adaption, contracting suppliers that were committed and motivated to work with the lean construction methodology was considered critical for project success. Thus, when deciding on the procurement strategy, the project management found it expedient to include measures that ensured that the
contracted suppliers held a sufficient level of competence, the appropriate resources and the necessary commitment in order to conform to the project requirements. When operating on behalf of a public client, the KHiB management team was required to design the procurement process in line with the law on public procurement, NS 8485 and Statsbygg’s supplementary contract terms, “Blåboka,” which, to some extent, limited the team’s opportunities. A restricted tender procedure was used such that the actors had to fulfill financial and technical qualifications specified by the client prior to making an offer.

In addition to the qualification criteria, potential suppliers were evaluated according to the award criteria set by the KHiB management team. When designing the award criteria, the management team decided to reduce the importance of price in the contractors' propositions. Instead, qualitative evaluation tools were employed to ensure that the contracted suppliers were capable and committed to work using the lean construction method. With this approach, price was weighted at 60 % and the contractor employees' CV was weighted at 20 %. For the final 20 %, the management team included an innovative criterion: the assessment of lean task understanding and/or experience. For this, the contractors were asked to illustrate and describe how they planned to manage propulsion handling and organize their logistics in line with the lean construction principles. This is seen as an untraditional tendering process performed by a public client. Based on the procurement process, the project organization for the KHiB-project was established (see Appendix 2 and 3 for total evaluation of suppliers and weighting form):
4.2.2 KHiB-Project Execution

Project planning phase and contract terms crucial for project success. In addition, the willingness, aims and intentions of all the actors involved are also critical. Project actors must possess a positive attitude towards change and a willingness to work under structured conditions when implementing lean construction (Statsbygg 2014). In order to succeed with the implementation of lean construction and the project in general, a lean cooperation memorandum was developed. This served as a reference for all involved actors to lean understanding and the project’s goals and objectives. Additionally, all contracted project actors were required to attend a TTP seminar in Germany that was organized by the takt expert, Porsche Consulting.

4.3 Empirical Findings and Analysis of the Case Study

In this section, the case findings and analysis are presented together. The data collection method was based on Figure 1 developed in the theoretical background and has the primary aim of adding empirical insight to the primary and sub-
research questions. The case study of KHiB is used as an example to provide an in-depth understanding of these research questions. Moreover, additional interviews and research beyond the case study was also conducted to illuminate the phenomena in a broader context.

The first part of this section addresses the role that the client plays in driving process innovation. The second part discusses the role the mechanisms play when driving process innovation.

4.3.1 The Role of the Client in Driving Process Innovation in the Construction Industry

In order to answer the sub-research question, “What role does the client play in driving process innovation in the construction industry,” empirical research was performed. This subsection describes the findings from the empirical research and the findings are analyzed throughout this subsection. From our findings, we derived a natural distinction between the perceived ability and responsibility to drive innovation which will be exploited in analyzing the findings regarding this sub-research question.

Our findings reveal different opinions and viewpoints regarding the client's role in driving innovation. The majority of the interviewees expressed that in a construction project, the client holds the greatest ability to drive process innovation because the client often sets the terms of conditions in the construction project. By being the project initiator, the client shapes the project with the contract model, planning phase and construction process.

Some interviewees also argue that consultants and designers have a greater ability to drive process innovation than other actors. Because these actors are contracted in the early stage of the project, they plan and determine the construction process. In contrast, other actors are contracted later in the planning process and have to abide by the premises established at the earlier stages. This limits the later involved actors' ability to drive process innovation. Among all project actors, the contractor is often considered to hold the most variable ability to drive and shape process innovation. However, its ability depends on the chosen contract model.
and the terms and conditions set for the project. Overall, these findings suggest that a majority of the interviewees perceive the ability to drive process innovation is the greatest for the actors at the top of the hierarchy in the PBO.

These findings reflect the situation in the KHiB-project. The management team set the premises and the contractors were contracted at a later stage. Thus, interviewees stress the role of the top management as important for the organization's ability to pursue process innovation internally. For Statsbygg, the pursuit of process innovation in terms of lean construction is not an essential focus of the organization. Hence, our findings indicate that the KHiB-project team did not receive sufficient support from actors at different levels in the management team of Statsbygg required when driving lean process innovation. Findings therefore highlights that the ability to drive innovation is greater when the initiative is rooted in the organization’s strategy.

Regardless of which actor in the construction project that is appropriated with the greatest ability to drive process innovation by the interviewees, the importance of “innovation champions” is recognized by the interviewees. Many argue that by diffusing new knowledge and taking initiatives, innovation champions play an important role on the industry's ability to foster and facilitate process innovation. In the KHiB-project, the project manager played an important role as an innovation champion in initiating lean construction and has, thus, been an important actor in fostering and facilitating process innovation.

However, it is a clear consensus among interviews perceiving the client to have the greatest ability to drive process innovation, but there are divergent opinions regarding the actors’ responsibility to drive process innovations in the industry. Some interviewees point out contractors as important actors for realizing the implementation of innovations and the project’s strategic vision. As a result, the interviewees argue that the contractors have a great responsibility to pursue process innovation in the construction project. Another significant finding from the study is that the majority of the interviewees also recognize collective efforts from all actors in the construction project as a critical factor for the success of process innovation. This was exemplified by a contractor and an interviewee from the client firm highlighting that the rationale behind pursuing innovation often is
to improve the efficiency in the construction project with the motivation of improving their own bottom line, and therefore all actors has responsibility to drive the innovation. It is, thus, evident that the client is a particularly important actor in driving innovation, but all actors have a responsibility to foster, facilitate and drive process innovation. Collective efforts and adaption from all actors are thus considered essential for project success.

The majority of the interviewees regard the client as the actor with both the greatest ability and responsibility to drive process innovation in the industry because of the client’s ability and opportunity to implement change. Many mention that public clients, in particular, have the greatest ability and responsibility to drive innovation. Public clients have an important social responsibility to pursue the Parliament's stated policy and, thus, a mandate to pursue innovation and further develop the industry. Some interviewees also argue that public clients have greater responsibility to use their resources in a way that contributes to increasing efficiency when using taxpayers' money. The interviewees from the client company seconded these opinions regarding their responsibility to drive innovation. The CEO of Statsbygg stated, “We aim at performing our business effectively. In addition, we have in our mandate to develop the construction industry on behalf of the government; from that perspective, it is also important for us to drive process innovation.” Interviewees from some contractor firms observe that public clients also have greater leeway in their budgets to take on the risks and uncertainties associated with pursuing innovation. With this, they have greater ability and responsibility to drive innovation.

When discussing the role of the client and the other actors' ability and responsibility to drive process innovation, the interviewees recognize a variety of barriers that hamper the pursuit of process innovations. The majority of contractors regard the client's choice of contract model and the terms and conditions set as decisive regarding the contractors' ability to initiate and promote innovation in the construction project. Additionally, some interviewees argue that certain business models can hamper the ability to adapt to major changes in the construction process. Several interviewees within the client organization also stress that the laws of public procurement limit their potential to tailor the contract
in order to facilitate and foster innovation. Finally, several interviewees argue that the fragmented nature of the construction industry diminishes the overall innovation level because success with process innovation on an industry level requires convincing many small actors to conform and adapt to new requirements together. In sum, our findings indicate that the perceived barriers in driving process innovation are structural.

4.3.2 The Role of the Mechanisms in Driving Process Innovation in the Construction Industry

Semi-structured interviews and internal firm documents were used to answer the sub-research question, “What role do formal and informal mechanisms play in driving process innovation in the construction industry?” Because the mechanisms used to drive process innovations, like lean construction, can be divided into formal and informal mechanisms, the empirical research was divided similarly. This subsection presents the empirical findings and the accompanying analysis, first with the formal mechanisms followed by the informal mechanisms.

4.3.2.1 The Role Played by Formal Mechanisms in Driving Process Innovation

Formal mechanisms such as organizational structures, laws, regulations and procurement systems are argued to affect the innovation potential in a construction project. As this study limits the research to the formal mechanisms within the procurement systems, the following sections provide findings related to contract models and the procurement process, respectively.

The formal contract between actors exists for all large construction projects and sets the standards and the requirements for the execution of the project. The contract is rarely used as a mechanism to impose innovation, however, in the KHiB-project, Statsbygg took actions towards innovation by using the contract as a formal tool to foster innovation. When the client is the innovation initiator, a DBB contract model is typically preferred because the contract model enables the client to control and monitor the innovation process. For the KHiB-project, a DBB model was therefore used to ensure that the contractors do not fall back to a traditional mindset. The client argued that contractors in the industry do not possess a holistic view of the client’s intent in the execution of the project with
extensive use of TTP. It was therefore not suited to use a DB contract model and let the contractor take on the responsibility of implementing innovation efforts in the KHiB-project. Some contractors, however, do not favor a DBB contract model, and claim that the model and the accompanying bureaucracy in the project limit their opportunity to suggest and develop innovative solutions in the project. Despite this, the actors not directly involved in the construction of KHiB agree with Statsbygg regarding the suitability of a DBB contract model for client-driven innovation.

Several interviewees raised concerns regarding the degree of involvement by the contractors in the planning phase of KHiB. As illustrated in Model 2, the KHiB management team planned 80 percent of the TTP prior to the inclusion of the contractors in planning phase C. This limited the contractors' ability to exert influence in the planning of the takt wagons. Thus, some contracted contractors raised concerns about their ability to perform optimally. Because all actors would have possessed a holistic view of the KHiB-project, an earlier involvement would have resulted in a better understanding of the TTP and overall execution of the project. Other interviewees argue that the DBB contract model and the late involvement of the contractors are not in line with the principles of lean construction, specifically LPS. The client, on the other hand, claims that the contractors' lack of understanding of the complexity within TTP hinders an early involvement. Therefore, it was considered necessary by the KHiB management team to plan 80 percent of the project before including the contractors, as earlier involvement would have increased the complexity in the project and resulted in more risks and higher project costs.

Statsbygg claimed that there is a lack of maturity in the industry. As a result, they wanted to use the tendering process as a tool to compel lean construction in the industry and raise the overall competence level. For this, the client sought to secure the best suited contractors for applying lean construction principles in the KHiB-project. The traditional use of qualification criteria was used in the KHiB tendering process. An overall problem in the industry, however, is that the qualification criteria hamper the contractors’ ability to suggest innovative solutions. For instance, a contractor providing an offer to the KHiB-project was rejected solely based on its ability to deliver a customized door. Rather than
evaluating their proposal for alternative doors, Statsbygg disqualified the contractor outright.

The introduction of the innovative award criteria in the tendering process of KHiB, however, was positively welcomed by the industry. All actors, including the contractors who were not contracted, expressed that a 20% lean experience/understanding award criterion was a step in the right direction towards improving the Norwegian construction industry. Particularly, the criterion sent a clear message to the construction industry in Bergen about the importance of lean construction. As a result, most contractors in this area now recognize the importance of understanding such tools. All contractors that were not contracted in the KHiB-project stated that they were motivated to use lean construction in the future. A minority, however, argued that this did not result in significant changes in their strategy nor measures to enhance their lean competence. Despite this, they are open to the use of lean construction in a future project if prompted by another actor. For the contracted contractors, the reaction was uniformly positive, and these companies were motivated to adapt to the criteria. In all, the findings show that Statsbygg created an awareness of lean construction among the contractors in Bergen.

The opinions regarding the assessment of the award criteria in the KHiB-project, however, are more divergent (see Appendix 2 and 3 for weighting of the qualification and award criteria). The concerns of the assessment were threefold: First, it is evident that some contractors did not provide an offer based on their own competence. Instead, they hired external consultants to write the lean description and “bullshited their offer,” as one interviewee put it. Second, because lean construction experience or understanding is challenging to measure, a contractor argued that the weighting of lean is unfair and solely based on the contractor's ability to write good offers. Finally, as lean construction experience is limited in the Norwegian construction industry, several well-suited contractors felt excluded because they did not understand Statsbygg’s requests or specific selection criteria. Thus, it was not the contractors’ willingness to apply lean that prevented the contractors to be contracted, but the strict criteria set. Formulating the award criteria in the tendering foundation was a challenge, and the management team of KHiB finds credence in this critique. Because this was the
first project initiated by Statsbygg that uses this specific award criterion, the client recognizes a need for further improvements in the tendering process. However, the client does not agree with the rest of the critique. An interviewee from the client organization argued that the most suitable contractors were contracted, by stating, “The contractor that did not get a high score on the lean understanding/experience criteria did not understand what we were looking for. Hence, they did not have the right experience.” Post rejection, some contractors wanted a feedback on the award assessment. As Statsbygg strives for development in the industry, the rejected contractors received a thorough review of the assessment upon request.

4.3.2.2 The Role Played by Informal Mechanisms in Driving Process Innovation

The pursuit of process innovations, like lean construction, increases the level of interdependence among the actors and requires a high level of collaboration during the construction process. In the KHiB-project, TTP permeates the construction project which makes the actors collectively dependent on each other. As the trades move through the building when using TTP, each actor is dependent on the front actor's ability to complete their work and is accordingly required to finish their activities so that the subsequent trade can begin as planned. The takt plan can be considered a fixed schedule with minimum slack. This makes collective commitment to the takt plan, mutual adaptation and collaboration among project actors crucial for project success.

When establishing and fostering collaborative relationships and an effective working environment, informal mechanisms play an important role. Any departure from the traditional construction process is associated with a high degree of uncertainty and risk for the actors involved. The study show that construction projects permeated by a high level of trust and commitment is, thus, essential for mitigating any resistance to change. Although all interviewees emphasize the importance of informal mechanisms like trust, collaboration and commitment, the challenges involved with establishing and maintaining these elements in a project is noteworthy. Interviewees stress that it is not sufficient to assign trust and commitment as explicit prerequisites for the project. Informal mechanisms take time to establish in a construction project and they must receive continuous focus in order to be maintained. In the KHiB-project, an important
The rationale behind planning phase C was to establish a common ground that facilitated trust, mutual understanding and respect for the different actors’ responsibilities and activities. Although all interviewees acknowledge the value of such initiatives, some interviewees also argue that mechanisms like trust and commitment are ultimately person-dependent. In other words, informal mechanisms occur and are preserved within the bounds and dynamics between individuals in each project.

To facilitate and develop informal mechanisms, an interviewee from the client company emphasized the importance of informal communication, “It is important to be present at the informal arenas in order to be able to understand how actors perceive the formal mechanisms in the project, if else it’s hard to address issues at an early stage.” The management team of KHiB focuses on being present at the construction site and accessible for the contracted actors. To accomplish this goal, the KHiB management team allocated two of the members to be located in Bergen in order to be present and “hands on” during the construction period, while the rest of the team commute to the construction site when needed. Coherent and orderly communication was also encouraged at all levels and among the relevant parties, especially actors operating on equal levels.

The majority of the interviewees also recognize openness and transparency as important informal mechanisms in driving process innovation. The interviewees emphasize the importance of a culture of openness that promotes asking questions and raising concerns. Such a culture, is argued by interviewees to be facilitated by transparency at all layers of the construction project.

The interviewees agree that this type of culture is present in the KHiB-project, as there is a clear focus on openness and transparency. For instance, whiteboards are present at the construction site and barracks, displaying takt plan. The overview of the progress and potential “red flags” are used to create transparency and openness. In the planning and execution of KHiB, the management team also devoted time and effort to pursue unifying initiatives, like workshops and team building activities. Despite these efforts, a contractor expressed concerns regarding the unwillingness of the KHiB management team to make necessary changes to the takt plan. The contractor argued that transparency by itself is not
\textit{enough} if the enforcement of the takt plan is inflexible to accommodate unforeseen challenges. The ability to respond, change and adapt is therefore additional informal mechanisms that need to be present in a construction project when driving process innovation.

In the KHiB-project, an important ambition of the project initiators is to ensure that the lean philosophy permeates the project organization in order to establish a common understanding of project goals and a lean culture. Actors must possess a strong loyalty to the system and mutual respect for all involved actors in order to ensure success. The KHiB management team perceived that lean requires a mindshift, visualized through the “lean plog” (Appendix 4). The lean plog demonstrates that project actors must all pull in the same direction and with equal effort from all actors. This is emphasized by the slogan “top-down, bottom-up, all-in.” Some interviewees stated that the orientation of actors towards a common goal nurtures an effective project culture and sense of community among project actors.

When implementing lean construction in a project, it is beneficial that all the actors involved have the same understanding of the term and philosophy. Based on the interviews, this was achieved within the KHiB management team. In the KHiB project, the TTP method, lean principles and approaches acquired from Porsche Consulting permeated the construction project. The contracted actors had to abide by and adapt to the requirements set by the management team. Some interviewees argued that this, to some extent, involved adopting the KHiB management team's perception of lean. For all actors in the KHiB-project and the industry more broadly, however, there are different perceptions of the term. All interviewees were asked to define their perception of lean construction, and the interviews revealed inconsistent answers. Some actors regard lean construction as a tactical term, other as an operational or strategically, and some interviewees perceive lean construction as a philosophy. In addition, some interviewees consider lean construction solely as a tool. The inconsistency of this perception can potentially result in challenges and misunderstandings during the project and its broader application to the industry.
4.4 Diffusing and Implementing Process Innovation across Levels

Our findings show a clear trend: the nature of the interplay between formal and informal mechanisms is recognized to be important for project success. The interviewees argue that the right balance between effective relationships, cooperation and trust among the project participants in concert with an appropriate contract is crucial for facilitating innovation in the construction project. Due to the uniqueness of construction projects, however, the innovation efforts driven in a project must be diffused beyond the single construction project in order to be preserved and benefit the overall industry. As a fragmented and complex industry, the construction industry faces challenges in diffusing innovation and should therefore have a significant focus on driving innovations from project level to industry level. Thus, this section of the chapter discusses the findings and analysis for driving process innovations at an industry level.

Several interviewees consider the importance of knowledge sharing in the industry as important for nurturing innovation. Openness and transparency are additional key mechanisms highlighted as essential for increasing the overall innovation level. Transparency, in the sense of sharing project models, planning schemes and best practices across industry actors, is typically viewed as essential in driving process innovation, like lean construction. Interviewees, however, also point out that challenges increase along with transparency because contractors perceive knowledge sharing as a threat to their competitive advantage. As a result, contractors often resist sharing their acquired competence and knowledge.

Forums, workshops and seminars are common arenas employed for sharing knowledge in the industry. Lean Construction Norge is an example of a forum that gathers experts and industry participants together to share their experiences with lean construction, in order to raise the awareness of lean construction. Such seminars and forums, like Lean Construction Norge, however, tend to attract the same collection of highly motivated individuals. It is a challenge to expand knowledge beyond this group of actors because a large number of actors in the industry do not see the value of attending seminars that they do not deem relevant to their daily work.
Several interviewees also stress the large knowledge gap between academia and practice. An industry participant interviewed argued that there is no point in publishing papers if the industry participants who are supposed to learn and benefit from such publications do not understand or have interest in reading the papers. The interviewee argued that a higher degree of formative evaluation could tighten the bond between the construction industry and academia, possibly resulting in greater incorporation of the research into practice.

Other interviewees argue that the only way to succeed in diffusing knowledge within the industry is to use a pilot project that practically illustrates the innovation idea. This can include creating a platform for discussion by promoting an innovative project, inviting industry actors to visit the construction site/building and holding seminars. The management team of KHiB greatly focuses on sharing their knowledge of lean construction to the Norwegian construction industry. To this end, they have invited industry actors to the construction site, held seminars all over Norway and plan to make a public final report of the project by sharing both their positive experiences and the areas that can be improved. This is a substantial step in the right direction because the diffusion of innovations is hampered by the general lack of public final reports in the industry.

Another problem associated with foreign and native Norwegian construction workers is the frequent transience from one project to another. The frequent shift in constellation of actors in a project prevents the involved actors from attaining an overall understanding of an innovation, like lean construction. Also, if the workers find a specific innovation useful in their daily work in a construction project, they face challenges adopting that innovation in future projects. The shift in the actor constellation from one project to another is also a hindrance for the project management team. This challenge is particularly significant for public construction projects in which the law of public procurement prevents the free selection and contracting of actors. Interviewees within the KHiB management team express their concern that they are not able to work together as a team and build on their experiences in the next lean construction project.
4.5 Summary of Empirical Findings and Analysis

This chapter presents the empirical findings and analysis of how to drive process innovation in the Norwegian construction industry, exemplified by the KHiB-project and with the empirical theme of lean construction as a process innovation. Interviews were conducted with actors from the KHiB-project, in addition to interviews with industry experts in the aim of enriching the research by providing a more nuance stand. The data and findings from the research were presented as neutrally as possible in order to encourage the transferability of the research.

To review, the construction industry suffers from a low innovation level and efficiency rate due to several factors. The interviewees deem the industry actors as conservative and suffering from silo thinking. This hampers learning and innovation in the industry. As the contract driven nature of the construction industry does not sufficiently encourage or reward innovative solutions in the contractors’ offers, the incentives for pursuing innovation in the industry are also limited.

The interviewees expressed inconsistent views concerning the client's role in driving process innovations, like lean construction. Because the client shapes the project, some interviewees argue that the client has the greatest ability to drive innovation efforts in a construction project. According to the interviewees, the public client is believed to hold the greatest responsibility of driving innovations because they possess an important social responsibility in pursuing the Parliament's stated policy and have requirements in their mandate to pursue innovation and develop the industry. Contractors typically are contracted at a later stage in the planning process and are bound by the established terms and conditions. As a result, they have limited potential to introduce innovations. Individual employees within the PBO, however, can formulate innovative ideas that are then championed and shared within the network. Such innovation champions are considered to have a great ability in driving innovation. Finally, all actors in the network have a responsibility to facilitate and foster process innovations because success with process innovation requires collective adaption.

The actors who manage the construction project set the terms of conditions through formal contract agreements. Once the formal conditions of the project are
set, the innovation initiator has the ability to use the contract as a formal tool to compel innovation within the project. Interviewees also expressed that informal mechanisms, such as knowledge sharing, commitment, transparency and communication, are essential to establish the collaborative environment that is required when working after the principles from lean construction. An effective and appropriate contract as well as the right balance between good relationships, cooperation and trust among the project participants is crucial for facilitating innovation in a construction project. Thus, it is evident that the interplay between formal and informal mechanisms is important not only for project success, but also for the diffusion and implementation of process innovations in the construction industry.

In order to improve the overall efficiency in the construction industry, process innovation must be transferred from project level to industry level. No interviewees or documents describe a clear solution regarding this challenge. The interplay between formal and informal mechanisms is essential, however, a combination of several factors need to be present in order to succeed.
CHAPTER 5 - DISCUSSION

This chapter discusses empirical findings in relation to the theoretical background presented. With this, we offer a thorough discussion of research findings and address the fundamental research question of this study, “What drives process innovation, like lean construction, in the construction industry?” The aim is to reveal different aspects of this research area and put these issues into a broader, industry-wide perspective in order to provide an overall understanding of process innovation, like lean construction, in the construction industry.

Because the theoretical background and empirical findings address many interesting aspects of process innovation, we chose to extract what we consider as the most significant and revelatory findings from our study to provide a thorough and in-depth discussion. Three main topics of discussion were therefore chosen. In order to answer the first sub-research question, the first discussion topic address the client's role in driving process innovation. As lean construction is used in this research as an example of a process innovation, the focus in the first discussion topic will be on the role of the client in driving lean construction. The second discussion topic will be based on the second sub-research question, and thereby discuss the role played by formal and informal mechanisms, and the interplay between these. As the aim of this research is to contribute to a better understanding of how to drive process innovation in the industry and not solely within a single project, the third topic for discussion will address how to diffuse and implement innovations across levels.

5.1 The Client's Role in Driving Lean Construction

Our study shows that client, as in its role of being the initiator of the construction project, have a greater ability and responsibility to drive process innovation relative to other actors in the construction project. This is in line with previous research acknowledging that the client inhabits an extremely important role in driving innovation in the construction industry (Blayse and Manley 2004; Lim and Oforis 2007; Kulatunga et al. 2011). Our study also confirms previous research that draws a distinction between public and private clients in the respect of their ability and responsibility to drive innovation (Hartmann 2008; Widen et al. 2008). The client in the KHiB-project, a public client, acknowledges its
extended responsibility to facilitate and foster innovation, which is illustrated in their mandate stating to develop the construction industry on behalf of the government. This is apparent through Statsbygg’s efforts in developing and improving the construction industry by setting higher requirements with the use of BIM, and their extended focus on HSE and environmental standards.

Despite the client's ability to facilitate innovation in the construction industry, the client can also serve as a barrier to innovation. When the client drives innovation, Ivory (2005), for instance, expresses concern that a dominant client leadership may hamper innovation if pursuing an excessively narrow focus on particular forms of innovation. Several examples in our study indicate that the interviewees share a similar concern. In the KHiB-project, the management team took a dominant role in shaping and driving the innovation effort. 80 percent of the construction process was planned in advance of contracting contractors. The KHiB-project is regarded as unique because it is characterized by a high degree of complexity with few standardized and repetitive solutions. As a result, some question the client’s intent in facilitating a TTP method in the construction process because the complexity and non-repetitive nature of the project, to some extent, do not meet the typical standards for a TTP project (Linnik 2013). This example aligns with Green and May’s (2005) discussion of dominant discourses in the construction industry. The authors state that common perceptions of effective performance and innovation are likely to be adopted by client organizations due to the perceived pressure in the socioeconomic environment to imitate others’ success, regardless of the suitability of such practices for the client's specific construction project (Green and May 2005). As increased attention has been given to the tools and techniques of lean construction in the Norwegian construction industry, our study indicate that TTP may have been initiated in the KHiB-project primarily due to such isomorphic pressure.

Two concerns consistently recur in our study with regards to the introduction of TTP in the KHiB-project. First, the empirical data indicate that the late involvement of contractors in the planning process contradicts the lean construction philosophy encouraging early involvement of all actors and collaborative problem-solving (Ballard et al. 2009). Second, some interviewees argue that it is misleading to state that the lean construction philosophy permeates
the KHiB-project because the construction process simply is based around a tool adopted from Porsche Consulting. According to previous research, theoretical insight into the lean construction philosophy is important in diffusing and implementing lean construction (Ballard and Howell 2003; Chesworth et al. 2010). Our findings indicate that the KHiB management team lacked an interest in and failed to seek a broader understanding of the theoretical background and academic interpretation of lean construction when introducing the lean principles to the construction process.

However, the implementation of TTP in construction projects is relatively novel, and research and discussions of TTP are still ongoing in the lean construction community (Seppänen et al. 2010). It is, therefore, understandable that the KHiB management does not organize the project solely on best practices derived from academic research. As a result, the project can help to further theory-development within the field of TTP. Because each construction project is unique, the transfer of theory into practice requires some adjustments to the context of each project. The dominant role taken by the client in driving innovation by implementing lean construction and TTP in the KHiB-project must be viewed in light of the lack of similar projects in the industry to draw experiences and knowledge from. It can therefore be questioned whether the academic perception always fits the project setting or if lean construction philosophy must evolve in concert with the project.

Regardless of the concerns regarding the adequacy and the implementation process of TTP, the study shows that the majority of the interviewees consider the client's dominant role in the pursuit of process innovation in the KHiB-project to be critical for project success. In this project, the client provided leeway in its budget for innovation, thereby defying the associated risks and uncertainties inherent to innovative changes. The strong internal competence of the KHiB management team, including the high level of involvement throughout the duration of the project and the early commitment to pursue lean process innovation, is also praised by the interviewees.

In addition to the client, our study shows that other actors also play an important role for succeeding with process innovation. This confirms previous research finding that process innovation cannot be achieved by one isolated actor (Winch
The pursuit of process innovations, like lean construction, requires collaboration and interaction among project actors. Collective adaptation and commitment towards the new project setting is, thus, viewed as critical for success. All actors in the construction project must contribute toward the implementation of the innovation.

For example, this study shows that consultants largely influenced and shaped the innovation effort pursued in the KHiB-project. Porsche Consulting, which the project manager of KHiB met by a coincidence at a seminar, supported the KHiB team during the planning phase. Porsche Consulting were also contracted to help disseminate their understanding and knowledge of lean construction and TTP through lectures, takt planning meetings and collective workshops. Despite this, some interviewees criticize the management team and the project manager of KHiB for not seeking other sources of information or for failing to take into account a wider perspective of the lean philosophy in the KHiB-project. Still, it must be acknowledged that Porsche Consulting has increasingly been contracted by other actors in the Norwegian construction industry. This suggests that there is a general, positive reaction to the consultant’s conceptualization of lean construction and TTP. Moreover, this example where the consultant has influenced the innovation by being a knowledge broker, illustrates that actors other than the client can play an important role in driving process innovation (Kometa 1995; Meland 2000; Gann and Salter 2000; Blayse and Manley 2004).

The construction literature has repeatedly emphasized that the presence of central individuals who drive innovation by promoting, distributing and implementing knowledge and innovations is crucial for innovation success as new ideas and knowledge stem from individuals (Blayse and Manley 2004; Winch 1998; Barlow 2000). This is in line with the case findings in which the interviewees also recognize the importance of so-called “innovation champions” for driving innovation in a project. Our study indicates that the extensive innovation efforts made in the KHiB-project by the client is due to a dedicated project manager who initiated lean construction and TTP in the construction process and committed himself personally to push the project through. The efforts made by the innovation champion, thus, resemble a bottom-up approach for driving process innovation (Cheung et al. 2015).
Nam and Tatum (1997) characterize innovation champions as well-prepared individuals who not only have extensive experience but also possess adequate resources and power. Our findings show that it is not easy, however, to empower project managers to act as innovation champions and provide them with the required resources to drive innovation, owing to the conservative nature in the construction industry. As a result, such empowerment requires a top management that is amenable and flexible to change (Cheung et al. 2015). Moreover, our findings indicate that the organizational structure in Statsbygg provides project managers with the required freedom and flexibility to determine how to execute the construction process within the boundaries of Statsbygg’s business model. This flexibility can, thus, be regarded as a factor that facilitates innovation in the client firm, since the project managers to a certain extent are empowered and enabled to pursue process innovations like lean construction (Nam and Tatum 1997; Cheung et al. 2015).

In addition to acknowledging that the organizational structure impacts how innovation is pursued in firms, previous studies emphasize organizational rigidity as a barrier to innovation in larger firms (Brandon and Lu 2008). Our research demonstrates that the decoupled nature of Statsbygg also results in silo thinking within the client firm. Moreover, our findings indicate that the focus on innovation in the client organization does not seem to be systematic nor significant because there are few incentives for project managers to pursue such process innovation in their projects. The lack of a systematic focus on innovation, therefore, suppresses the client's ability to drive process innovation. Instead, the project manager’s intrinsic motivation primarily seems to determine whether they will adopt the role of innovation champion and make fundamental changes to the construction process.

In addition to an innovation initiator, Mossmann (2009) argues that a successful implementation of lean construction principles in a project requires a consistent strategy and praise from the top management. The findings from our study confirm previous studies in assigning top management support as a prerequisite for success with innovation (Nam and Tatum 1997; Cheung et al. 2015). Because the incentives for top management and lower level employees may differ, all actors in the vertical hierarchy must be committed to the innovation effort to
In the case studied, a challenge occurred when one actor in Statsbygg’s hierarchy was not committed and did not provide sufficiently support for pursuing process innovation by implementing lean construction. This calls into question whether the top management in Statsbygg has a sufficient and systematic focus on fostering and facilitating innovation at a project level.

In addition to an innovation initiator, previous research assigns top management support as a prerequisite for succeeding with innovation (Nam and Tatum 1997; Cheung et al. 2015). The findings from our study are in line with Mossmann (2009) finding that a successful implementation of lean construction principles in a project requires a consistent strategy and praise from the top management. Because the incentives for top management and lower level employees may differ, all actors in the vertical hierarchy must be committed to the innovation effort to ensure success. In the case studied, a challenge occurred when one actor in Statsbygg’s hierarchy was not committed and did not provide sufficiently support for pursuing process innovation by implementing lean construction. This calls into question whether the top management in Statsbygg has a sufficient and systematic focus on fostering and facilitating innovation at a project level.

It is consistently emphasized that lean construction implementation begins with commitment from the project leadership and is sustained with a culture of continuous improvement (Aziz and Hafez 2013). Moreover, prior research finds a collective understanding of the lean concept as a precondition for effective lean implementation (Freire and Alarcón 2002; Green and May 2005). In addition to the project manager’s efforts in initiating lean process innovation, several examples from our study indicate that strong leadership commitment permeated the KHiB-project in the planning and construction phases. In fact, the KHiB management team inhabited the role as “lean champions” (Ballard and Howell 1998) in sharing their knowledge and understanding of lean construction throughout the duration of the project by initiating workshops, establishing lean guidelines and arranging interactive learning sessions. The KHiB management team also recognized a collective understanding of the philosophy as crucial. They sent all project actors to attend a workshop in Germany in order to establish a common understanding of TTP and lean construction. Thus, in driving lean
construction, the KHiB management team made sufficient efforts to combat conceptual vagueness and facilitate a collective understanding of lean.

It is clear that the KHiB management team promoted a strong culture of collaboration and mutual commitment toward project goals in driving lean process innovation. In line with the tenets of lean philosophy, there is an ostensible focus on establishing ownership and responsibility among the different project actors (Green and May 2005; Eriksson 2008). The implementation of TTP requires each project actor to be aware of their responsibility and the relationships and dependencies among different trades. This awareness is perceived to facilitate a collaborative culture and trust, helping all actors to pull in the same direction (Kadefors 2004).

The lean construction literature also repeatedly emphasizes the need for a culture of continuous improvement. Project actors must be encouraged to initiate ideas and new solutions to solve the problems that are encountered both on and off site (Ballard et al. 2003; Sui Pheng and Fang 2005). To achieve this, the KHiB management team has, as earlier mentioned, strived to create a culture of openness and transparency. However, previous studies conclude that actors in the construction industry do not perceive they have sufficient opportunity to state their opinions and concerns (Riley and Clare-Brown 2001). Empirical findings from the study indicate that the interviewees share the same concern. Despite the focus on continuous improvement and openness in the project, it was argued that the takt plan and the following construction process were too rigid, which hampered the contractor's ability to make changes in the takt plan, and thereby limited their ability for continuous improvement. It should therefore be considered if the project actors should be involved at an earlier stage when the client drives process innovations, like lean construction.

In sum, clients are recognized to inhabit great responsibility and ability to drive innovation. However, process innovation requires all actors to be committed and adapt to the changed requirements, and are therefore important in succeeding with process innovation. Interviewees further recognize innovation champions to be important actors in driving innovation. However, top–management commitment
and support is seen by interviewees as a prerequisite for succeeding with implementing process innovations, like lean construction.

5.2 The Role of the Interplay between Formal and Informal Mechanisms

By conferring prior literature, it becomes evident that the formal and informal mechanisms play an important role in driving innovation in the construction industry. When treating the mechanisms independently from each other, it is apparent that both mechanisms are crucial for project success. Our empirical findings comply with this as it became evident that the tendering process has played a crucial role in compelling innovation to the KHiB-project. Moreover, the importance of commitment has been highlighted as a significant factor for the project manager and innovation champion to facilitate and drive innovations.

Because purchased services and materials account for up to 90 percent of the total project costs for the client (Kumaraswamy et al. 2000), the procurement and contracting process is of great strategic importance in a construction project. Designing formal mechanisms is typically regarded as essential for promoting a culture of innovation and compelling innovative solutions (de Valence 2010). According to Bygballe et al. (2014), however, the public procurement process and culture of competitive tendering are some of the main factors that result in short-term relationships which again hamper the innovation level in the industry. This view is confirmed by the empirical data which find that the traditional public procurement and contracting process prevents learning and innovation in the construction industry because the price-focus allows few incentives for innovative solutions.

For example, interviews argue that the traditional contract models, which are neglecting the importance of informal mechanisms, can serve to hamper innovation. It has been argued that the traditional DBB contract model, which is used in the KHiB-project, hampers the innovation efforts in a construction project (Osipova and Eriksson 2011). In this contract model, the contractors strive to incorporate amendments due to the late involvement. However, as the client has a high degree of power to establish the conditions of the working environment, Statsbygg argued that the innovation efforts can be forced into the project when
using a DBB contract model and it was therefore suitable when contracting for KHiB as the industry's focus on innovation is not satisfactory. Another barrier to the DBB contract model, is that contractors strive to coordinate among the involved actors due to the lack of communication and joint problem-solving efforts among the client, designer and contractors during the construction project (Korczynski 1996). This was apparent in the KHiB-project, where the late integration of contractors became a great challenge because the contractors did not have an opportunity to suggest innovative solutions for the execution of the project or affect the project design (Osipova and Eriksson 2011).

Researchers have, thus, in recent years emphasized the importance of informal mechanisms for driving innovations (Kadefors 2004). Trust, communication, long-term relationships, among others, are regarded as essential for an innovative culture. The importance of informal mechanisms was also apparent in the case study. For example, as none of the KHiB-project actors had previous experience with TTP, the KHiB management team required all contracted actors to attend a TTP seminar in Germany. The aim was to establish a common ground that facilitated trust, mutual goals and respect for the different actors’ responsibilities and activities. Moreover, the client firm acknowledges the importance of communication and transparency on the construction site by arranging frequent TTP meetings. This is in line with relevant literature that emphasizes communication of the project goals and the rationale behind the innovation to all involved actors in order to mitigate any resistance to change (Cheung et al. 2015). However, solely depending on informal mechanisms for driving innovation is problematic due to the challenges related to building and maintaining intangible mechanisms.

Project actors must work cooperatively in the planning and execution phase of a project and find appropriate construction solutions, share knowledge and promote innovative solutions throughout the project (Harty 2005). Because informal mechanisms are intangible and difficult to implement and maintain (Bresnen and Marshall 2000b), a sole reliance on the informal mechanisms does not have a significant effect on innovation. Thus, the interplay between formal and informal mechanisms play a remarkably important role in driving innovations in the PBO, and thereby an important role in shaping the project actors’ behavior. A
combination of these mechanisms both enables and constrains the conduct of project members and, thus, affects the innovation potential in the construction project and in the industry (e.g. Zaheer and Venkatraman 1995; Poppo and Zenger 2002). The importance of the interplay between these mechanisms is also confirmed for the KHiB-project by a majority of the interviewees.

Therefore, frustrations with the traditional contract models such as DBB and DB has resulted in the adoption of cooperative contract models that encourage both formal and informal mechanisms by incentivizing cooperation (Bygballe et al. 2015). As traditional contract models can hamper the implementation of innovations, such as lean construction, due to the traditional mindset and the lack of involved planning and coordination, partnering agreements, for instance, has been argued to overcome these challenges (Sarhan and Fox 2013). Partnering can be viewed as a cooperative tool used to engineer relationships and promote learning and knowledge-sharing (Porwal and Hewage 2013), and the interviewees’ previous experiences with partnering agreements are mainly positive at a project level.

Despite the conscious aim to develop informal mechanisms in the project, researchers underscore the dominant role played by formal tools in partnering agreements (Bresnen and Marshall 2002). Thus, new contract models have received significant attention in academia, but the industry has yet failed to implement innovative contract models successfully or to a great extent. Experts suggest that this is a result of the industry’s focus on short-term benefits and one-off contracts. In addition, interviewees from the case study indicate that another problem with cooperative models, such as partnering agreements, is the laws of public procurement that hinder free-choice in the contracting of suppliers. This observation is also confirmed in literature (Bygballe et al. 2010). Some interviewees, however, suggest that industry actors must learn how to use the laws to their benefit rather than as barriers that must be overcome. Still, the short-lived nature of the contracts makes it difficult to transfer any positive gains from a specific partnering agreement from one project to another. This further hampers knowledge sharing and the establishment of long-term relationships.
The Integrated Project Delivery (IPD) is another example of a collaborative contract model, and this model has been successfully implemented in the construction industry in the USA. The IPD contract model is often considered somewhat different from other collaborative approaches because IPDs bind the actors contractually to the pursuit of a common goal by sharing risk and reward (Ashcraft 2014). This model is deemed highly appropriate for complex construction projects, like the KHiB-project, but requires an authoritative client that is engaged, committed and able to provide strong leadership throughout the project. Because the contractors are contracted early in the planning phase, the IPD model is also considered effective for driving innovations. Additionally, the model often includes the use of BIM and lean construction, both of which require all involved actors to implement innovations.

The IPD model illustrates the opportunity of implementation of innovations at the industry level. Additionally, concepts associated with an IPD model were used in the construction of a public hospital in Norway, which reveals that the laws of public procurement are no hindrance to this implementation (Bygballe et al. 2015). Some interviewees argue that an IPD model would have been more suitable for the KHiB-project than the existing DBB model due to the project’s focus on lean construction and process improvement. However, other interviewees criticize the use of incentives because actors normally seek to maximize their own incentives. The Norwegian construction industry has not yet witnessed the benefits of an IPD. However, Tønsbergprosjektet, a public hospital construction project in Norway, offers forthcoming empirical evidence in this regard as the first extensive project operating with a Lean IPD contract model.

Changing the contract model towards collaborative agreements also affects the procurement process. Thus, the interplay between formal and informal mechanisms is also regarded as essential in the procurement process in order to facilitate innovation. Recently, researchers argue that the client must focus on finding the best contractor in terms of value for money rather than the contractor with the lowest bid (Eriksson 2013). To accomplish this, they emphasize the inclusion of soft parameters in the award criteria that promote improved project performance (Manley 2008, Porwal and Hewage 2013). Statsbygg has taken several actions to improve the procurement process that are, so far, regarded as
successes. As illustrated in the case study of KHiB, the client included soft parameters, such as an understanding/experience of lean construction, in the tendering process with the aim of improving the construction process. Both the contracted contractors and the firms that were not contracted state that Statsbygg’s effort to drive innovations was necessary because the industry itself is not mature enough to make extensive changes in the overall construction process on its own initiative. Thus, it is crucial to break the culture of price-based competitive tendering in order to increase the level of learning and innovation in the industry. The findings indicate that these criteria resulted in increased awareness of lean construction in the industry, and that the client's effort to drive innovation in the industry was successful.

However, findings from the interviews illustrate that there is room for improvement in the assessment of the award criteria. When introducing novel requirements in the award criteria, such as lean construction, the initiator should prepare the industry prior the procurement process. It was argued by some interviewees that the award criteria were unclear. As a result, it was challenging to write a convincing offer. On the other hand, Statsbygg held several project information seminars and therefore argued that the industry had the opportunity to prepare themselves for lean construction. Regardless of the contractors’ understanding of the soft criteria, the inclusion of soft criteria in the tendering process requires the client to invest sufficient effort into writing a project description and into the assessment process (Cheung et al. 2015). Some interviewees suggested that the client should conduct interviews with the firms that place offers in order to gain an overall understanding of the contractors’ real understanding of lean and their motivation to implement such innovations. This would limit the contractor's ability to “bullshit” its experience and/or understanding of lean construction. By extension, the client should be willing to evaluate a contractor’s motivation to adopt the innovation regardless of their precise experience with such process improvements. The exclusion of inexperienced contractors can potentially result in a knowledge gap between the contractors that had the opportunity to implement innovation and those that are willing, but have not had the opportunity to adapt.
Statsbygg also received criticism by interviewees for its use of qualification criteria. The traditional restricted tender potentially excludes well-suited contractors because the qualification criteria undermine the contractors’ ability to suggest innovative solutions, as illustrated in the KHiB-project where a potential supplier was disqualified due to the inability to deliver a customized door. This observation accords with previous research that acknowledges the insufficiency of a restricted tender for team integration and collaboration in a construction project (Cicmil and Marshall 2005). The KHiB management team, however, claims that a restricted tender process is an adequate tool for developing long-term relationships with contractors, because it provides the client with an opportunity to exclude certain contractors by tailoring the qualification and award criteria to fit only the preferred contractors.

Some interviewees, however, recommend an open tender procedure. The argument stated was that an open tender can stimulate competition among the contractors and, thus, facilitate innovative solutions. Furthermore, by encouraging more communication through the tender process, contractors can have the ability to suggest amendments to the qualification criteria (Eriksson and Westerberg 2011). It can be questioned whether an open versus a restricted tender would have an effect or not when driving innovations, but it can be concluded that the client must be willing to communicate and adopt alternative and innovative solutions throughout the tender process.

In sum, by facilitating innovations in the procurement process, the KHiB-project can be regarded as successful because both formal and informal mechanisms and the interplay between these were adopted and accounted for. Despite this, some interviewees state that the KHiB management team’s ability to change and adapt to proposed changes is limited in both the planning and construction phases of the project. Thus, there is an ostensible gap between the willingness for innovation if it is initiated by the client, and the unwillingness if it is driven by other project actors. As a result, interviewees argue that the client should focus on continuous improvement and knowledge sharing among all industry actors by facilitating transparency and openness in the project.
5.3 Diffusing and Implementing Process Innovation across Levels

In the aim of driving the construction industry forward with more efficient construction processes, innovation needs to be transferred from the project level, and implemented at an organizational and industry level. As illustrated in the study of the empirical findings, there is a mismatch between the high level of learning and innovation at a project level and the translation of innovation to the industry level. This accords with Harty (2005) and Bygballe and Ingemansson (2014) who found that there is a lack of effort directed towards driving innovations from project level to the industry level. Thus, empirical findings of the case study confirm existing research, and further indicate that most actors perceive the responsibility for improving the industry to lie beyond the boundary of individual actors’ tasks, and is regarded as “someone else’s job.” As a result, the process of translating innovation is insufficient in the construction industry and a great hindrance to succeeding with innovation. In order to drive innovations from project level to the industry level, researchers consider two basic steps essential (Winch 1998; Harty 2005): diffusion and implementation.

The features related to the diffusion of innovation to the industry sphere are threefold (Harty 2005). First, collaboration among actors in the PBO is essential. Actors in a construction project are tightly coupled, and the interdependence among the actors requires cooperation (Dubois and Gadde 2002a). Since the late 1980s, it is recognized that collaboration within construction projects requires increased integration and coordination among the distinct construction teams (Cicmil and Marshall 2005). In response to these findings, the industry has initiated several actions that promote collaboration, like lean construction (e.g. Koskela 1992), as exemplified in the case study of KHiB.

The empirical data find that the industry actors perceive the cooperation in the KHiB-project to be adequate, as a result of the process innovations implemented. For instance, there is a great focus on communication and transparency on the construction site, and frequent meetings regarding the TTP are held for all involved actors in order to promote optimal cooperation at the site. Despite these efforts, the empirical data find that there are still communication-related challenges and cultural inconsistencies at Norwegian construction sites due to the great number of foreign construction workers. The effective communication of an
innovation, such as lean construction, can be complex and challenging. As a result, foreign construction workers often fail to understand the meaning and value of innovation efforts, according to several interviewees. Resistance to change is also present for some Norwegian construction workers because these actors tend to possess a conservative mindset. It is, therefore, important for all project actors to understand the value of the innovation and the reasons for implementing innovations such as lean construction (Chesworth et al. 2010). Thus, it can be argued that in order to implement an innovation at a project level, it is important for the client to make the innovation effort in the project a collaborative act. All of this underscores the importance of collaboration in order to diffuse innovation.

Second, in order to diffuse innovation successfully, it is necessary to communicate the performance of an innovation beyond the boundaries of a PBO (Harty 2005). This is a well-documented challenge in the industry for several years by both researchers (e.g. Miozzo and Dewick 2002) and industry professionals. Several efforts, however, have been initiated to overcome these challenges. For instance, Cheung et al. (2015) argue that the industry should promote an environment that facilitates bottom-up, top-down and lateral communication in the industry and involve all industry actors in innovative practices. In the KHiB-project, there are significant efforts made to involve all industry actors and diffuse the knowledge from the project to the unbounded sphere. In particular, the KHiB management team focuses on disseminating lean construction knowledge by holding seminars and arranging guided tours on the construction site.

Further on, when communicating the performance of a project, interviewees highlight the importance of giving some slack to pilot projects when evaluating the KPIs because innovation initiatives frequently fail before they attain success. Interviewees further argue that it is crucial to communicate both the successful experiences, as well as challenges that were faced. The transparency of sharing project results, however, might be challenging because most actors do not have any incentives to share company secrets and view this knowledge sharing as a threat to their competitive advantage.
In the construction industry, another important topic stressed by interviewees is the diffusion of knowledge from academia to practice. Researchers argue that industry actors lack the capability to absorb and act upon the practices that are proposed in academic papers (Gann 2001). This view is confirmed by the empirical findings, where it was argued that few construction workers have an interest in academia as the majority do not have a high educational degree. Some interviewees also indicate that the lack of interest in published research originates from a pervasive opinion that learning in the construction industry is best achieved through practice. New practices and research findings must therefore be conveyed more directly to the industry actors in order to gain acceptance.

There is an inconsistency between academia and the practitioners regarding the perception of academic terms like lean construction. This challenge is also present in the Norwegian construction industry in form of a conceptual and terminological vagueness. Our study confirms previous studies in finding that lean construction is conceptualized very differently across industry participants (Green and May 2005; Pettersen 2009), and thus hamper the diffusion of this process innovation across firm boundaries. Several examples in our study indicate that project actors’ terminological take on lean construction is inconsistent, even amongst interviewees within the same company. For instance, Veidekke uses “involverende planlegging” (IP), Bravida uses PP7, while Skanska uses “trimmet bygging” when defining lean construction. As the findings show that different variants and versions of lean construction are present even within local contexts, a unified consensus might be difficult to derive. On the contrary, the different applications of the tools and techniques of the term can potentially drive the development of lean construction in the Norwegian construction industry forward.

In addition to the conceptual vagueness, it is found in the case study that the perception of the lean construction philosophy within the industry is inconsistent. Herrala et al. (2012) argue that actors in the construction industry focus their attention on the operational perspective of lean construction, neglecting the philosophical and strategic perspectives. Findings from the case study indicate that this concern is also valid for the Norwegian construction industry. While several interviewees state that their firms are working to apply the tools and techniques from lean construction systematically in order to improve the current
working methods, there seems to be difficulties in persuading industry actors to consider lean construction as a value creation process. Sage et al. (2012), among others, state that the misuse of the lean tools is a challenge. Empirical data find that the interviewees share the same concern with the role of TTP in the KHiB-project and the efforts made by the client in diffusing process innovation above project and firm boundaries. In sum, it can be argued that in order to communicate the performance of the innovation above the boundaries of a construction project, the industry should focus on transparency and facilitate an environment for communication amongst all layers of actors.

The third feature required to diffuse innovation from project level to industry level, is a focus on the maintenance and constant development of inter-organizational relations (Harty 2005). The construction literature has repeatedly emphasized that the industry suffers from silo-thinking, fragmentation and companies operating in a loosely-coupled system (e.g. Dubois and Gadde 2002a). As a result, relationships in the industry are perceived superficial. According to the empirical findings, such superficial relationships are an outcome of the culture of competitive tendering in the industry and the laws of public procurement that hamper the free choice in the hiring of contractors. This frequent shift in the constellation of actors between projects and the fragmented nature of the construction industry are, thus, strong hindrances to diffusion of innovation to the industry level (Håkansson and Ingemansson 2013).

To overcome these challenges, the KHiB management team has applied for resources to conduct an R&D project in which lean construction is used and the same actors from the previous KHiB-project are contracted. If the application is accepted by the government, the same constellation of actors can work together in order to further develop lean construction and TTP in a subsequent construction project. With this, these actors will be able to drive lean construction knowledge further.

It is questionable, however, if such efforts will result in an even greater knowledge gap between the actors with some lean construction experience and the actors who are motivated to use lean principles, but have not yet had the opportunity. This results in a dilemma regarding the development of innovation
prior to diffusion and implementation to the industry level, versus inclusion of all actors at an early phase of the development of an innovation to derive additional innovative solutions and thereby drive innovation collectively in the industry. Regardless of this dilemma, a cultural mind shift in the industry is required.

As illustrated in the previous discussion of contract models, more focus is put on collaborative forms and long-term relationships in the industry the recent years. In particular, collaborative contract models, such as partnering agreements, have gained much attention (Bresnen and Marshall 2000b). Despite the increased attention, the impact of these agreements in public sector construction is limited (as illustrated in section 5.2.1). In the aim of developing inter-organizational relationships, Gluch et al. (2013) argue that boundary-crossing activities like forums and seminars should be used as platforms to share knowledge. Although these platforms are important tools for diffusing innovations, the empirical findings indicate that such platforms tend to attract the same, dedicated actors. In addition, most actors do not find seminars and forums directly relevant to their daily work or simply do not have the time to attend. As a result, it is challenging to expand knowledge and develop relationships beyond these platforms. The development of long-term relationships in the construction industry requires the industry to be more transparent, open and directed to long-term benefits rather than short-term gains (Eriksson 2013).

Once the innovation has been diffused beyond the spheres of the construction project, the innovation has to be implemented at an industry level. For the implementation of innovation at the industry level, previous studies highlight the importance of an authoritative actor who monitors and manages the implementation process through the use of formal mechanisms (e.g. Harty 2005; Widen et al. 2008). This study confirms prior research that argues for the client to adopt this authoritative role. The findings from the contracting process of the KHiB-project illustrate that the formal mechanisms used to monitor and manage the implementation of lean construction are yielding results. The particular contract model and procurement process for compelling implementation of lean construction in the KHiB-project have also resulted in an increased awareness of lean construction in the Norwegian construction industry.
One area of concern when implementing innovations to the industry level is the potential for inconsistencies between the innovation initiator and the actor to implement the innovation. The use of tools that facilitate a lean construction philosophy may fail if the requisite informal mechanisms are neglected. The importance of collaboration, trustful relationships and transparency throughout the implementation processes are therefore crucial for success (Kadefors 2004). Other concerns are the differing incentives and actors’ internal strategic visions that may affect the implementation. Thus, the client plays an important role in communicating the objectives and benefits of the innovation, and must establish an innovative culture in the industry and promote openness and informal feedback from all actors. It is therefore argued by the researchers that the interplay between the formal and informal mechanisms are essential for implementing innovations, like lean construction, at an industry level.
CHAPTER 6 - CONCLUSION

In this study, we set out to explore what drives process innovation, such as lean construction, in the construction industry. The current state of the industry is arguably characterized by a low level of innovation, and there are notable challenges related to the diffusion and implementation of process innovations within projects and across project and firm boundaries. Owing to the complex dimensions of the construction industry, our study was narrowed to investigate the client's role and the use of formal and informal mechanisms in driving lean process innovation. Combining these topics and applying them within the context of the construction industry, fills a noticeable gap in the general theoretical literature. This motivated a thorough and comprehensive analysis that proved to be valuable and resulted in relevant findings. This study contributes to theory development and practical implications in mainly four areas:

First, when driving process innovation in the construction industry, it has been widely discussed in academia which actor that has the greatest ability and responsibility to drive innovation (e.g. Blayse and Manley 2004; Harty 2005, Lim and Oforis 2007; Widen et al. 2008). Our research can contribute to enrich this discussion. It is apparent through our study that public clients inhabit an extremely important role in driving process innovations, due to their authoritative role in shaping the construction project. Because the industry is immature and lacks experience in achieving process innovation, client driven process innovation was found in the study to be highly necessary and confirmed to have a positive effect in fostering and facilitating innovation in the industry. Moreover, innovation champions were found, in particular, to be critical components in order to pursue process innovations. This was exemplified by the innovation efforts made in the case study, as the innovation initiated in the project were solely based on the innovation champion’s intrinsic motivation and dedication. Further, the findings from our study demonstrate that the low innovation level in the industry suffers from the absence of top management support and a systematic focus on process innovation in general. Thus, this study contributes to theory development in demonstrating that process innovations require collective efforts and adaptations from all industry actors. However, the industry relies on authoritative clients taking on the responsibility to initiate and drive innovation. For practice, this means that there is a need for the establishment of a systematic approach
within and beyond the boundaries of construction firms that promotes and facilitates the innovation initiator’s efforts in all layers of the hierarchical system.

The second area of contribution addresses the mechanisms used to drive process innovation (e.g. Bresnen and Marshall 2000b; Poppo and Zenger 2002; de Valence 2010; Bygballe et al. 2015), an area where existing research covering the interplay between formal and informal mechanisms is perceived as limited. The construction industry is deemed contract driven and dominated by a culture of competitive tendering, and academia have repeatedly emphasized the negative effects of traditional contracts on innovation efforts in the industry. The findings from this study illustrates that there is a need for the adoption of more cooperative contract models in the industry, as these models account for the interplay between the formal and informal mechanisms. For practice, this means that industry practitioners should look towards cooperative contract models such as partnering agreements and IPD models when pursuing lean construction projects, despite the concerns raised regarding the suitability of these in public construction projects. Additionally, the interplay between formal and informal mechanisms plays a crucial role in other formal mechanisms such as the procurement process, as these are proven to foster innovation in the project studied. Thus, this contributes to theory development in this field of research. For example, the inclusion of soft parameters in the tendering foundation is found to be important in order to drive the industry towards operating with a more innovative culture. Reducing the importance of price in the award criteria is perceived in our study to be solely positive and can, thus, be utilized in order to achieve process innovation. However, this study finds that there is a lack of accounting for informal mechanisms in the qualification criteria, and in the assessment of the award criteria. As a result, this tends to prevent innovation efforts in the procurement process. Increased openness, communication and discussions with all actors in both the qualification criteria process and the assessment of the award criteria are argued to facilitate and foster the innovation efforts. Hence, an implication for practice from our study is the importance for the industry actors to facilitate and account for informal mechanisms within the formal mechanisms when initiating and driving innovation. The state of the construction industry is not easily changed, but challenging the traditional mindset within contracting and the
procurement process is proven to facilitate innovation in the industry and should thus be increasingly pursued.

The third contribution from this study relates to the identified need for establishing a common understanding of the concepts of lean (e.g. Green and May 2005; Pettersen 2009; Herrala et al. 2012). Such a consensus can help to combat the conceptual vagueness surrounding the term that currently exists in the Norwegian construction industry and complicates the diffusion of lean process innovation. However, the different applications of the tools and techniques of this term can potentially drive the development of lean construction in the Norwegian construction industry forward. Nevertheless, an implication for practice derived from this study is the importance of the client to take a central role and increasingly focus on establishing a common ground for all project actors in order to make the implementation of lean principles a collective act.

The fourth and final contribution area concerns the development and improvement of the construction industry, as prior research stress that there is a fundamental need to translate learning and innovation from the project level to the organizational and industry level (e.g. Ling 2003; Harty 2005; Bygbaalle and Ingemansson 2014). Our study contributes to theory development in finding that a prerequisite for bridging this gap is to make process innovations within the project a collective act by making all actors understand the value of the process innovation. In order to diffuse the knowledge above the boundaries of the construction project, however, the culture of silo thinking must be broken both internally within organizations and in the industry in general. Hence, the emphasis on learning across projects is proven in this study to be crucial. Because the constellation of actors in the industry is constantly changing, an implication for practice is that the industry has to exploit the interplay between formal and informal mechanisms to a greater extent in order to develop long-term relationships in the industry that contribute to preserve knowledge across projects. This study adds knowledge to the theoretical understanding of how to diffuse and implement process innovation across levels, by concluding that the client must use its authoritative role to drive process innovations in the construction industry by leveraging the interplay between formal and informal mechanisms in order to promote innovation across levels and to the industry.
6.1 Limitations and Future Research

Some limitations concerning this study should be acknowledged. Generally, the time and capacity constraints we were bounded by limited the study to concern a single case study. Multiple case studies of different clients’ role in driving innovation could have offered a more general understanding of what drives innovation in the construction industry. On the contrary, the single case study allowed for an in-depth investigation of the complex phenomena. It would be interesting, however, to study similar projects, such as the previously mentioned Hospital in Tønsberg where they apply an IPD contract model and use VDC, in order to compare and contrast findings.

In addition, it would have been beneficial for our study to investigate the role of the interplay between formal and informal mechanisms in other formal mechanisms, such as in organizational structures, infrastructure systems, policies and regulations. This would have provided the study with a broader exploration of how to drive process innovation in the construction industry.

Based on the aforementioned limitations of the thesis, suggestions for future research follows. First, research directed towards isomorphism in the context of the Norwegian construction industry represents an interesting research angulation for future research, as the diffusion of lean construction might be subject for isomorphic pressure. Further, existing research addressing how to drive process innovation from project level to industry level appears to be inconclusive, especially within the context of lean in the construction industry. Of particular interest is the lack of theoretical understanding on how to diffuse and implement lean construction by using formal mechanisms and at the same time account for the informal aspects this process innovation requires. Finally, further theory development within TTP can also help to contribute to the development of best practices in the industry. Performing additional in-depth case studies directed towards projects concerning the above mentioned issues can provide further understanding of these topics and contribute in filling these existing theoretical gaps.
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APPENDIX

APPENDIX 1: GENERAL INTERVIEW GUIDE

Del 1: Introduksjon
Hensikt: Gi intervjuobjektet praktisk informasjon angående intervjuet og motivasjonen bak masteroppgaven.

- Introduksjon av oss
- Forklaring av bakgrunn og motivasjon for masteroppgaven
- Informere intervjuobjektet om digitalt opptak og konfidensialitet av opptaket

Del 2: Bakgrunn – Bedrift og intervju objekt karakteristikka
Hensikt: Få et overblikk av bedriften og intervjuobjektet.

- Kan du gi en kort beskrivelse av din bedrift?
  - Hvordan anser du deres posisjon i næreringen forhold til andre aktørers sin posisjon?
- Hva er din rolle i bedriften og KHiB prosjektet?

Del 3: Innovasjon
Hensikt: Hvordan ser bedriften på innovasjon i den norske byggenæringen.

- Hvordan vil du beskrive produktiviteten og innovasjonsgraden i byggenæringen på generell basis?
- Hva anser du som de største barrierene for innovasjon i næringen?
- Hvordan vil du beskrive din bedrifts innovasjonsfokus, vilje og evne?

[Videre fokus vil bli lagt på prosessinnovasjon, hovedsakelig lean]

- Hva er din bedrifts kjennskap til lean construction?
- Ser du på implementering av lean construction som et taktisk, operasjonelt eller strategisk verktøy?
- I hvilken grad har din bedrift implementert lean construction, og hvordan har dere gjort det?
- Var det eksterne eller interne drivkrefter som var avgjørende for implementeringen av lean construction?
Del 4: Hvem
Hensikt: Hvem bør drive prosessinnovasjon i den norske byggenæringen.

- Hvilke muligheter har din bedrift til å påvirke prosessinnovasjon i byggenæringen, og i hvilken grad utnytter din bedrift disse mulighetene?
- Hvem er den største aktøren til å hindre prosessinnovasjon, og hvem har den største muligheten til å drive innovasjonen?
- Hvem synes du bor drive prosessinnovasjon i byggenæringen?
- Kan én persons ide få gjennomslagskraft i byggenæringen?
- Har en offentlig byggherre et større samfunnsansvar enn andre byggherrer til å drive innovasjon i byggenæringen?

Del 5: Hvordan
Hensikt: Hvordan bør initiativtakeren drive innovasjon i byggenæringen.

Uformelle verktøy:
- Hvor viktig vil du anse verdien av gode relasjoner i næringen som avgjørende for å få til endring av byggenæringen?
- I hvilken grad blir det fokusert på å skape en innovativ kultur i din bedrift?

Formelle verktøy:
- Hvordan påvirker kontraktsmodellen din evne til å innføre innovasjonstiltak i byggeprosjektet?
  - Vil du foretrekke en Totalentreprise eller byggherrestyrte modeller (for eksempel general entreprise, del entreprise, hovedentreprise, samspillskontrakt).
- Hvordan påvirker din bedrifts egen forretningsmodell/prosjektmodell din evne til å innføre innovasjonstiltak i byggeprosjektet?
- Hvordan passer lean inn i deres prosjektmodell?
- Hva synes du om at Statsbygg “tvinger” innovasjon ved å ha med lean forståelse/erfaring i kontraheringsprosessen?
- Statsbygg forhåndsdefinerte prosessinnovasjonstiltaket i prosjektet (lean) uten å inkludere de andre aktorene som skal være med å utføre innovasjonen. Vil dette hemme eller fremme innovasjon i prosjektet, og derav innovasjon i næringen generelt?
- Hvor tidlig bør de kontraherte aktorene involveres i prosjektets innovasjonsarbeid?
- Opplever du at byggherrer har samme begrepsforståelse av lean construction som din bedrift?

Annet:
- Hva anser du som kritiske suksessfaktorer for å få til en endring i byggenæringen?
• Nå som dere har tatt i bruk lean i KHIB prosjektet, tror du lean kommer til å påvirke resten av organisasjonen i fremtiden?
• Hvordan tar man innovasjons initiativ videre fra prosjektnivå til å påvirke hele den norske byggenæringen?

Del 6: Oppsummering og avslutning

Hensikt: Gi intervjuobjektet muligheten til å belyse temaer som ikke er diskutert.

• Hva synes du generelt om utførelsen av KHIB prosjektet? Hva har fungert godt, og hva anser du som de største utfordringene?
• Er det noe annet du har lyst til å legge til som ikke er belyst?
• Du er velkommen til å sende oss en e-post dersom det er noe du ønsker å legge til senere
## APPENDIX 2: QUALIFICATION CRITERIA & ASSESSMENT

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<th>Entreprenør B</th>
<th>Entreprenør C</th>
<th>Entreprenør D</th>
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<tr>
<td><strong>Tekniske og faglige kvalifikasjoner</strong></td>
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<td>1. prosjektreferanser</td>
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<td>JA</td>
<td>NEI</td>
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## APPENDIX 3: AWARD CRITERIA & ASSESSMENT

### Price:

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<td>09 MURARBEIDER</td>
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<td>15 DØRER</td>
<td>6 730 531</td>
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<td>16 LÅSER OG BESLAG</td>
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<td>17 TEKKEARBEIDER</td>
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<td>18 BLIKKENSLAGERARBEIDER</td>
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<td>19 METALLARBEIDER</td>
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<td>20 GLASSFELT OG GLASSDØRER</td>
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<td>26 BYGNINGSMESSIGE HJELPEARBEIDER EL</td>
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<td>29 DIVERSE BYGNINGSMESSIGE ARBEIDER</td>
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<tr>
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<td>113 749 189</td>
<td>94 812 591</td>
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<tr>
<td>+ 25% mva</td>
<td>28 437 297</td>
<td>23 703 148</td>
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<tr>
<td>Tilbudssum inkl mva</td>
<td>142 186 486</td>
<td>118 515 738</td>
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### 2. Regulering av kontraktssummen

| Opsjon på fastpristillegg             | 2 000 000     | 915 000       |
| + 25% mva                             | 500 000       | 228 750       |
| Tilbudssum inkl mva                   | 2 500 000     | 1 143 750     |

### 4. Regningsarbeider
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<td>650,00</td>
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<td>195,000,00</td>
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<td>Ingeniør (from offer)</td>
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<td>14%</td>
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<td>Evaluation Rental</td>
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<td>70,000,00</td>
<td></td>
</tr>
<tr>
<td>Evaluation 4 regnungsarbeider</td>
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<tr>
<td>+25% mva</td>
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<td>552,469,07</td>
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<tr>
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<tr>
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<td>97,937,466,80</td>
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<tr>
<td>Sum to evaluation incl mva</td>
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Comment:

Options were not evaluated as these were cut-off lists that the project does not wish to activate as enterprises came within the budget.
### CV:

<table>
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<tr>
<td><strong>BIM, Lean filosofi og metodikk, Begrunnelse for sammensetting</strong></td>
<td>Dette dokumentet finnes ikke i tilbudet, men mye av dette kan leses i CV'er og i Lean filosofi.</td>
<td>Tilbyder benytter Involverende planlegging (IP) som metodikk og redegjør for hvordan dette fungerer. Metodikken kan sammenlignes med Lean metodikk og bygger på mange av de samme prinsippene. Tilbyder svarer på en tilfredstillende måte hvordan tilbudt personell tidligere har jobbet med BIM og IP.</td>
</tr>
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### Oppsummert vurdering


| SCORE | 8 | 10 |

### Lean experience/understanding:

<table>
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### Total calculation of award criteria:

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<th>Lean</th>
<th>CV</th>
<th>Pris</th>
<th>SUM TOTA LT</th>
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Page 114
<table>
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<tr>
<th>Entreprenør</th>
<th>Vekttall (%)</th>
<th>Sum vektede karakterer, Svk</th>
<th>( S_1 = 0.01 \times V \times Svk )</th>
<th>Vekttall (%)</th>
<th>Sum vektede karakterer, Svk</th>
<th>( S_2 = 0.01 \times V \times Svk )</th>
<th>Vekttall (%)</th>
<th>Karakter for pris KP</th>
<th>( S_3 = 0.01 \times V \times KP )</th>
<th>( S_1 + S_2 + S_3 )</th>
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APPENDIX 4: LEAN PLOG
APPENDIX 5: PRELIMINARY REPORT
Preliminary Thesis Report

- Driving Process Innovations in the Construction Industry -

Hand-in date: 15.01.2016

Campus: BI Oslo

Examination code: GRA 19003

Programme:
Master of Science in Business
Logistics, Operations & Supply Chain Management
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<td>2.2 Justification and Contribution to the Research Area</td>
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<td>2.3 Limitations</td>
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<tr>
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<td>3.4.2 How: Key Methods of Driving Innovation in the Construction Industry</td>
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The Norwegian construction industry has suffered from low production efficiency and increased operating costs over the last two decades, indicating a need for change in the construction processes. There has been a consensus in both academia and the industry that supports the need of increased productivity and innovation growth, thus several actions have been initiated to alter these problems. The objective of our research is to understand what drives process innovations in the construction industry, with an emphasis on the client's role in initiating innovations by setting requirements and the industry actors’ response and adaption to these. More specifically, we will study how tools and methods in the procurement systems are used by the client to force and thereby drive innovation in the industry. We will illuminate this by conducting a case study of the construction of the Academy of Art and Design in Bergen (KHiB) where the innovative principles from lean construction has been introduced by the client in order to improve the construction process.

In the first part of the research proposal, an introduction of the case company is presented, the problem statement is defined, and the research area is described. Further, we justify the research proposal by arguing that our research is relevant since it addresses a well known problem which in the recent years has been on the agenda and widely discussed. In the next part, we examine the existing literature within our research area and identify that there is a lack of theoretical understanding regarding the use of procurement systems as tools to facilitate innovation in the construction industry. Moreover, we discuss the suitable research methodology where our choices of research strategy and design are justified. We present how we intend to collect the necessary data and how to ensure that our research achieves high scientific credibility. Lastly, the reader will find a discussion of ethical considerations followed up by a tentative project plan for our master thesis.
1. Background and Motivation of Study

The Norwegian construction industry, after the petroleum industry, has contributed to the second greatest value-creation in the country over the last couple of decades. In 2014, the industry employed 230,000 and had an annual turnover of 450 billion Norwegian kroners. Given the industry's crucial role in the economy, the cost efficiency, productivity and the investment rate in the construction industry is of great importance. The industry is amongst the most complex of all industries (Gidado 1996), and the complexity of the industry is constantly increasing due to higher requirements, more regulations of projects, and globalization. Considering the complexity of the construction projects, there is a need for specialization and thereby outsourcing, which results in a highly fragmented supply chain characterized by a high degree of interdependencies between the actors (Bygballe and Goldeng 2012). Today, there are approximately 75,000 companies operating in the Norwegian construction industry, which of 97 percent employs less than 20 (Virke 2014).

During the last two decades, the industry has suffered from low production efficiency and operated with extensive costs (e.g. Byggeindustrien 2012; Hørlyk 2015; Thunes 2015). In 1992, Koskela (1992) stated that the problems in construction are well known and that the productivity level in the construction industry lagged behind the level in other industries. Later on, Winch (1998) argued that the rate of innovation in the construction industry is lower than most other sectors, and appears to be falling further and further behind. There has been a consensus in both academia and the industry that supports the need of increased productivity and innovation growth. Several actions have been initiated to alter these problems. In 2005 the Norwegian government, in collaboration with powerful actors in the industry, decided to undertake initiative to enhance a more effective and profitable development of the industry (Byggekostnadsprogrammet 2008). The research and development project Byggekostnadsprogrammet was implemented with the objective of enhancing the quality of construction processes and the overall competence level in the industry. Despite the initiatives, the Norwegian industry is still regarded as more conservative than other industries and is suffering from low efficiency and a low investment rate in R&D. In 2015, the governmental Committee of Productivity highlighted the importance of increased productivity and an increase in the R&D investments and thereby the
Traditionally, innovation efforts have been initiated within the field of technology and product innovations. Over the last decade, however, the traditional innovation methods have been challenged. Innovation efforts in the construction industry have turned towards changing the overall construction processes, in the desire of improving project performance and increasing the overall efficiency of the system (Slaughter 2000). Acknowledging the lack of focus on processes improvements and value creation in the construction industry, Koskela (1992) advised the industry to turn towards the manufacturing industry for inspiration, where the lean philosophy emerged and is a success. Today, lean principles in the context of the construction industry is widely applied and has resulted in the emergence of the field “lean construction”. The evolvement of lean construction is also impacting the Norwegian construction industry, where tools and methods have been increasingly implemented in the purpose of process improvement.

1.1 Case Study

On the basis of a parliamentary resolution in spring 2013, the Ministry of Education commissioned a letter dated 25.06.2013 addressed to the public client Statsbygg to realize the construction project of KHiB within the predetermined budget of 1038 million Norwegian kroners. The purpose of the project is to construct a new Academy of Art and Design in Bergen (KHiB), in order to expand the offer of education opportunities within this field of study in Norway.

The client, Statsbygg, is Norway’s largest building commissioner and property manager in the civil sector, operating with a revenue of 4.159 billion NOK in 2014 and a value of 37 billion NOK (Statsbygg 2015). Statsbygg is an industry leader and regarded as a role model for the construction and property management industry in Norway. For the execution of the KHiB-project, Statsbygg have contracted Snøhetta as the main designer, Rambøll as the advisor (RIB), Porsche Consulting as the lean expert and advisor, and Veidekke as the main building contractor. The organization chart is illustrated in Appendix 1.

Statsbygg has taken innovative actions in order to improve the construction processes. Statsbygg performs the construction of KHiB with the use of lean construction principles, making the project the first extensive project in the Norwegian construction industry where these principles have been implemented both in the planning- and construction phase. In addition to including clear
performance requirements of all involved contractors by enforcing them to conform to the lean construction requirements, the client has also introduced new supplier selection criteria in the tendering foundation.

In the tendering foundation, Statsbygg have reduced the importance of price in the suppliers’ proposition. They have introduced a new assessment, which includes an innovative lean task understanding/experience criteria that accounts for 20 percent. In addition, 20 percent of the tender foundation will be an assessment of the suppliers’ relevant experience based on reference projects and the offered employees’ CVs, while the last 60 percent is based on price. The lean task understanding/experience selection criteria is based on the suppliers’ illustration and description on how they tend to manage propulsion handling, organize their logistics and overall planning in the project in line with lean construction principles. This allows Statsbygg to assess the supplier’s lean capabilities and lean understanding. Additionally, this can also be seen as a tool to ensure that the suppliers are capable to adapt to the new processes in the construction, which is crucial as implementing lean principles in the construction processes requires adjustment and commitment from all actors.

2. Problem Statement

Based on the description of the KHIIB-project, the actors involved and the process innovation efforts implemented, this part will present the objective of the research. Further, the research question will be defined, followed by a justification and contribution of the research question. Finally, a clarification of the scope and limitations of the research will be presented.

2.1 Research Question

It is commonly acknowledged that change is needed in the construction industry to alter the challenges of low productivity, efficiency and investment rate in R&D. In order to successfully implement changes to the construction processes, it is important to acknowledge that innovation cannot be achieved by one isolated actor. The initiator of the innovation is dependent on other actors’ capabilities and willingness to change the construction process in order to succeed. As change requires collective cooperation and effort across firm boundaries, the question of whom has the responsibility of initiating and driving the innovation is frequently discussed. Clients are commonly considered to have enormous capacity to exert
influence on firms and individuals in a way that fosters innovation, and often
inhabits the role as the initiator. Despite the client's capability of exerting
influence of other firms, the most effective tools and methods to make the
implementation a collective act is vigorously discussed.

When making fundamental changes to the construction processes, like
implementing principles from lean construction, the need for interaction and
collaboration between the actors in a construction project changes. The aim of our
research is to understand what drives process innovations in the construction
industry, with an emphasis on the client's role in driving innovations by setting
requirements and the industry actors response and adaption to these. To examine
these mechanisms, we will do a case study of the KHiB-project and the actors
involved. Thus, the following research question has been developed:

*What drives process innovation in the construction industry?*

- *A case study of the innovation efforts made in the construction of KHiB*

### 2.2 Justification and Contribution to the Research Area

Our research question was developed through our interest of process
improvements, where the lean philosophy caught our attention. Further, we
wanted to study lean implementation within the construction industry, due to the
interesting aspects of the cost-competitive, complex and fragmented environment
that challenges the change of processes and innovations in general.

The research question is *relevant* because process improvement and
innovation in the Norwegian construction industry, which our case addresses, is a
well known problem and has in the recent years been on the agenda and widely
discussed both in media and in the industry (e.g. Erfaringer med Lean i
Byggebransjen 2014; Hørlyk 2015). The angulation is *novel* because it addresses
the tools and methods used by the client in the procurement systems to force and
ensure, and thereby drive process innovation in Norwegian construction industry
which is an area where existing scientific research is limited. Our research can
*contribute* in filling the gap in the theoretical understanding of what drives
process innovation in the construction industry, with an emphasis on the client's
role in driving innovations by setting requirements and the industry actors
response and adaption to these. We aim at illuminating the efforts made by the
client from different perspectives, mainly from key actors of the KHiB-project but also with supplementary viewpoints by independent industry experts. This will provide the construction industry with a holistic view on how this enforcement of innovation is perceived by the industry participants, and if the procurement system is an appropriate tool to drive innovation. We wish that our findings will provide a better basis for discussion of the best practices to drive and implement process innovation in the Norwegian construction industry. As we have already signed a formal contract with Statsbygg and they have assigned us a mentor that will help us with the execution of our research, we consider the feasibility of our research to be high. Additionally, our memberships in the Lean Construction Norway association will facilitate the connection to a broad network of industry experts that can provide us with different perspectives on our research topic.

2.3 Limitations

Our research will be conducted within the limits of the Norwegian construction industry, mainly focusing on the segment of institutional and commercial buildings in both the public and private sector. Due to the time and resource constraints that we are operating under, we will limit the scope of our research to the innovation efforts made in the KHiB-project by analyzing the case and the supplementary expert interviews. Consequently, our research we will only be able to illuminate an in-depth analysis of the client's role and efforts in driving process innovation, which will limit our ability to provide a balanced discussion on the key influencers of process innovation in the construction industry. Specifically, the focus of our research will be on the tools and methods used by the client in the procurement systems to force and ensure, and thereby drive process innovation. However, narrowing the field of study will help us reveal some interesting aspects regarding our research question, which had not been possible to expose if the scope was broader.

3. Literature Review

3.1 Aim of Literature Review

The overall aim of this literature review is to examine what drives process innovation in the Norwegian construction industry. More specifically, we will study how key industry participants can improve the innovation level by using
tools and methods, and thereby improve the overall construction processes. We will start by summarizing the characteristics of the construction industry, focusing on how this affects innovation. The next part of the literature review will provide an examination of the key innovation influencers, and the different tools and methods used to drive innovation. Further, theory on lean construction will be reviewed, before the concluding remarks and findings from the literature will be presented.

3.2 Characteristics of the Construction Industry

3.2.1 Complexity

A project-based organization (PBO) differ from the traditional, permanent organization. The permanent organization is defined by its goals, trying to survive by production processes and continual development. A PBO, however, is based on building up its knowledge, resources and value through projects with a temporary lifespan. Most project-based organizations can also be considered as a temporary organization within a permanent network. This means that in addition of coordinating within a specific project, the organizations have to coordinate beyond the project, and with other projects as well as other firms involved in the supply chains (Dubois and Gadde 2002a).

A construction project can be defined as a temporary organization within a permanent network, which makes the complexity of the projects high. Gidado (1996) claims that a construction project is one of the most complex of all kind, and the complexity in the industry is continuously increasing. He argues that the complexity stems from the large amount of resources involved and employed, the nature of an unpredictable environment, the scientific knowledge required, and from the interactions between numerous actors involved.

Dubois and Gadde (2002a) argue that the complexity in the industry can be divided into two main categories, namely uncertainty and interdependence. All construction projects are unique in technical, financial and socio-political terms, and is thereby exposed to uncertainties (Segerstedt and Olofsson 2010). The uncertainties also originate from the volatility of the demand in the industry. The interdependence among tasks represents the different resources brought together to form a workflow (Dubois and Gadde 2002a). Due to the extreme complexity, the client does not have the sufficient expertise required to carry out the construction by themselves. The project requires a large scale of different
expertise. Specialization and thereby outsourcing and subcontracting is therefore important. These characteristics result in a fragmented supply chain with several interdependencies, which again leads to uncertainties and risks. The interdependence can lead to misunderstandings between the parties, uncoordinated actions and lack of control and visibility (Geraint 2014).

3.2.2 Loose Couplings

On the construction site, there are tight interdependencies and a need for coordination between the involved actors. Dubois and Gadde (2002a) argues that there are “tight couplings” between the project participants. In the permanent network, however, there are “loose couplings” as there are no or little interaction between the organizations in the industry beyond individual projects. The culture of short-term market based exchange and competitive tendering with a strong focus on price result in a constant shift of actors across different construction projects (Bygballe and Ingemansson 2014). The focus on short-term profit for each project and the rapid change of actors hinder the possibility of long-term relationships in the industry, resulting in a “loosely coupled system”. Segerstedt and Olofsson (2010) adds that the uniqueness of each project, the discontinuity of demand, and the complexity in terms of number of actors involved are additional factors that problematizes the establishment and management of long-term relationships in project-based industries, such as the construction industry.

3.2.3 Low Long-Term Productivity and Innovation Level

The pattern of couplings in the construction industry seems to favor short-term productivity while serving as a barrier of innovation and learning. After the publication of Rosefielde and Mills’ article from 1979, innovation in the construction industry has been a focus of research. Previous research accuses the industry of having a low identifiable innovation rate, a lower efficiency level, a slower adoption of new technology, and/or a lower level of investments in R&D than other industries (Miozzo and Dewick 2002; de Valence 2010; Bygballe and Ingemansson 2014; Dubois and Gadde 2002a). Dubois and Gadde (2002a) argues that the loose coupled system is hampering innovation due to four main factors: Firstly, the temporary nature of a PBO do not promote learning. Knowledge and experience sharing across different, unique projects are normally inefficient and unstructured, whilst the projects’ time constraints make the individual and thereby the organizational learning problematic. Secondly, the strongly decentralized
structures in the industry makes the top management unfamiliar with the local environment and the specific projects. Thirdly, the absence of long-term relationships and continuous interaction between actors in the permanent network debilitate the innovation and learning process. Lastly, governmental regulations as well as industry standards favors often standard offerings in the tendering process, which will function as a barrier of creation of new solutions and innovation in the industry. Consequently, there has been a growing awareness of the importance of improving the innovation level in the industry over the last decades.

3.3 Innovation in the Construction Industry

The concept of “innovation” is variously understood and the definition is vigorously debated in research communities. Many professionals base their definition on Shumpeter (1934) who claims that innovation is an increase in economic growth by carrying out new combinations, and Schmookler (1952) who argues that innovation is an increase in productivity. In the construction industry, however, Slaugther’s (1998, 226) definition of innovation, based on Freeman (1989), is broadly used. She defines innovation as “the actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change”. Blayse and Manley (2004) describes innovation being either “technical” or “organizational”. Technical innovation includes changes in a process or a product, whereas organizational innovation includes changes in the organizational system and management techniques. Despite the various perceptions of the complex phenomenon, there is a general agreement amongst researchers that innovation is a vital proponent of success (Egbu 2004).

Given the constant cost-competitive environment in the construction industry, the common expectations and main focus of innovation activities are based on a reduction of design and construction-related costs. This is highly applicable for technology innovation within products, which has received a lot of attention in the industry. The revolutionary designing technology Building Information Modeling (BIM) have played a crucial role of reducing estimating and sustainability testing costs as the BIM solutions allow the project actors to explore and evaluate the project's constructability before it is built.

Over the last decade, however, research indicates that innovation in the construction industry have shifted more towards technology innovation within the
field of processes. There has been an increased focus of improvement in construction processes and improvement of the performance of the completed facility in the desire of improving the overall efficiency of the project (Slaughter 2000). For instance, the principles from lean manufacturing have increasingly impacted the Norwegian construction industry over the last years. There has been given attention to how lean construction, as an efficiency method, can improve the processes in the industry. Due to the importance of lean construction in the industry, this topic will be further elaborated in section 3.5.1.

3.4 What Drives Process Innovation in the Norwegian Construction Industry

So far previous literature and the industry itself has clearly stressed the need of improvement in the construction processes. Most stakeholders agree that there is a need of a process innovation, which can be followed up with two main questions: Whom should be the initiator, and how can the initiator drive process innovation in the desire of improving the efficiency and productivity in the industry?

3.4.1 Whom: Key Influencers of Process Innovation in the Construction Industry

A construction project consists of a myriad of different participants, and the interdependencies between these actors and systems are some of the main factors to the complexity of the project. In addition, the permanent construction firm are loosely coupled with a broad range of actors in a complex network. Winch (1998) illustrates with a model that construction projects are based on collaborative engagements with other organizations, making no successful innovation possible without including the supply chain and the related network (see Appendix 2). Blayse and Manley (2004) illustrates the range of construction project participants that are directly and indirectly involved in the project, and the need for active networking between them in a figure:

![Diagram](image-url)
Which of these participants whom should be the initiator of the implementation of a process innovation is broadly discussed.

**Regulatory Framework:** Government organizations’ main role of enhancing innovation in the construction industry is to facilitate an innovation and learning environment by legislation (Slaughter 2000).

**Technical Support Infrastructure:** Professional institutions, research communities and universities have the important role of being the “innovation brokers”, meaning the role of disseminate new knowledge to the industry (Blayse and Manley 2004, Winch 1998, Bygballe and Ingemansson 2014).

**Supply Network:** Manufacturers and suppliers of products and services usually operate in a more stable market, which means that they have the ability of learning from earlier experiences and build up knowledge. Therefore, they could be an important source of facilitating innovation. However, these actors have to be aware of the change required in the overall system when implementing their new innovations. There is thus a need of communicating to the project participants how the new innovation will increase the productivity and thus benefit all actors the industry (Slaughter 1993).

**Project-Based Firms:** Contractors, designers and/or consultant firms can be the initiator of implementing a process innovation to the construction site and/or in the planning phase. Their motivation is often based on achieving their strategic objectives in the long run and reduce their overall costs.

**Clients:** Traditionally, it is the customer that initiates and drives the innovation in an industry (Porter 1990). In the construction industry, this is also true as clients (the owner of the projects) are considered to have enormous capacity to exert influence on the industry in a way that promotes innovation and raises the standards of the industry (Barlow 2000; Blayse and Manley 2004; Winch 1998; Kilinc, Ozturk and Yitmen 2015). The innovative role of the client is so well accepted by academics that they are said to be key driver of innovation and performance improvement and therefore to be the most significant factor of improving the processes in the supply chains and thereby the industry.

**Innovation Champions:** Previous literature claims that the presence of central individuals who drives the innovation by promoting, distributing and implementing knowledge and innovations are crucial for innovation success as new ideas and knowledge stem from individuals. These central project participants are called “innovation champions” (Blayse and Manley 2004; Winch
However, given their important role of innovation success, we argue that innovation champions should be included in the model.

3.4.2 How: Key Methods of Driving Innovation in the Construction Industry

The literature considers the client as the most important initiator and key influencer of innovation in the construction industry. Consequently, further elaboration will mainly be conducted from a client's perspective with the focus on their efforts and methods to drive process innovation in construction projects.

As highlighted throughout the paper, collaborative engagements with other firms are required in the implementation of the innovation as most construction projects are operating in a tightly coupled system. In order to succeed, all project participants have to be committed and work collectively towards conforming to the new process requirements. Extensive research has pointed towards the importance of knowledge sharing, learning and an innovative culture when implementing the innovation. However, no significant, extensive change in the level of innovation has been identified after a myriad of theories within this field of research have been presented.

The problem seems to stem from the lack of concrete tools and methods required to stimulate innovation and change. Thus, de Valence (2010) claims that methods, laws and tools must be developed and applied in project based systems to make innovations a collective act, and therefore the best way to facilitate innovation within the construction industry lies in the procurement methods and systems. Additionally, van Weele (2014) argues that the procurement methods is crucial for innovation and change in an industry. Traditional competitive tendering rules, however, produce direct price competition and leave no room for innovation (Best and de Valence 2002). As the client determines the nature of competition in the industry and thus the extent of innovation, de Valence argues that changing the tendering process and the contract requirement by encourage innovative solutions will be a productive way to ensure collective innovation efforts in the construction industry.

We will now review literature within the field of procurement systems, more specifically how contracts and various types of payment prevents and promotes innovation.
Contracts

Larson and Gray (2014, 450) define a contract as “a formal agreement between two parties where the contractor obliges itself to perform a service and the client obliges itself to do something in return, usually in the form of a payment to the contractor”. The contract should outline the specific terms of the transactional obligations of the parties involved and provide for all possible contingencies. Contracts have a significant impact on project success as it shapes the behavior of the actors involved. Managing contracts is therefore a central part of any project procurement management system.

In the Nordic construction industry, there are mainly two contract types used (Osipova and Eriksson 2011). These are general contracts (GC) and design and build (DB) contracts. In GC the client is responsible for design, planning and function of a construction, while the contractor is responsible for assembly. This is the most widely used contract delivery method. In DB contracts, the contractor is responsible for both design and construction. de Valence (2010) argues that DB contracts do not encourage innovation since using the tender process to completely evaluate design, capability, time and cost is challenging and as the safeguarding hinders innovation solutions. In addition, the tendering rules produce direct price competition which leave no room for innovative solutions for the potential contractors.

Terms of Payment

Several authors have identified the form of payment as an essential aspect of contracts (von Branconi and Loch 2004; Larson and Gray 2014; Osipova and Eriksson 2011; Turner 2003). The three most common payment contracts are fixed-price contracts, cost-plus contracts and mixed-incentive contracts. In a fixed-price based contract, the contractor agrees to perform all specified work described in a contract to a pre-set fixed price (Larson and Gray 2014). In a cost-plus contract, the contractor is reimbursed for all justified costs plus an additional fee to cover overhead and profit (Larson and Gray 2014). Mixed-incentive contracts have fixed-price and cost-plus portions, with a focus on a shared target. This includes incentive fees, bonuses, penalties and target prices to compel the contractor to minimize costs without reducing the quality of the project (von Branconi and Loch 2004). The most commonly used type of payment in the construction industry is fixed-price contract.
Fixed-Price Contracts

In a fixed-price based contract, also called a lump sum contract, the contractor agrees to perform all specified work described in a contract to a pre-set fixed price (Larson and Gray 2014). The tendering is based on clients’ carefully determined requirements and cost estimates for the project to be executed. The fixed price is based on a competitive bidding from several contractors.

The fixed-price contract promotes innovation incentives from the contractors, as the contractors have incentives to be efficient and reduce total costs to increase their profit. However, innovation in the comprehensive construction industry is hampered, as the interactions between the client and the contractor is limited. The lack of interaction between the actors will also hinder innovation if the innovation initiative comes from the client as the preset innovation requirements prevents the contractors of being innovative in the tendering. Another preventing factor of innovation is the competitive bidding process. As earlier mentioned, due to the fact that contracting is mainly based on price, the cost focus in the industry hinder long-term relationships with contractors and thereby learning as there is a constant shift in actors across different project (Bygballe and Ingemansson 2014). However, the client can alter these issues by reduce the price requirements and apply other requirements which stimulates innovation. The fixed-price contract can also be used as a tool to enforce innovation to the construction process by setting clearly requirements in the tendering foundation.

Partnering Agreements

As construction projects are unique and extremely complex, identifying the risks that can emerge and include all desired requirements and strategies in the contract is impossible. As there is no perfect contract management system, Larson and Gray (2014) argues that formal contracts cannot replace the need for developing good relationships between the involved actors. During the 1990s, there was a clear trend away from traditional contracting and towards a more collaborative way of working (Turner 2003). Over the last decade, there has been a tendency of contracts being increasingly based on partnering arrangements where there is more focus on mutual goals, trust and cooperation between the project participants (Bygballe, Jahre and Swärd 2010; Dagenais 2007). The use of partnering arrangements will enhance collaboration between actors in the construction
industry and make the loose coupled system tighter. By treating the contractors as partners, performance will be stimulated at the project level and the organizational level will gain from innovation and learning benefits (Barlow 2000).

3.5 Lean

Scholars find it challenging to agree on a unified definition of the term lean, partly due to the myriad of various definitions and understandings that exist, but mainly due to the fact that lean is a continuously developing philosophy and its application differs for every situation. However, Shah and Ward (2007) define lean production as “an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability”. The automaker Toyota is accredited as being the founder of lean production, through its Toyota Production System (TPS) (Shingo 1989). One of the key objectives of lean is to differentiate between waste (muda) and value within an organization. Womack and Jones (1996, 15) define waste as “any human activity which absorbs resources but creates no value”. Further, they define value as “a capability provided to a customer at the right time at an appropriate price, as defined in each case by the customer”. Applying lean principles in the organization concerns continuously working towards identifying and eliminating waste from processes in the aim of leaving only value added activities in the value stream (Rother and Shook 1999).

3.5.1 Lean Construction

Lean as a concept has evolved beyond lean production and it continues to develop and influence other business areas. In the construction industry, waste is considered to be a characteristic for the supply chains, and a hinder for the supply chain performance (Arbulu and Tommelein 2002). Hence there is a need for improved efficiency and fundamental innovative changes to be made in the construction process in order to trim the production. In 1992, Koskela argued that there was a lack of focus on process improvements and value creation in the construction industry and suggested that the industry should look towards the lean philosophy for inspiration. Today, the term lean construction is widely applied and considered to be the application of lean manufacturing principles in the context of the construction industry. The most commonly used definition was constructed by Ballard and Howell (1998), which define lean construction as “handling a construction project as a temporary production system while
delivering the product with maximum value and minimum of waste”. Lean projects differs from traditional projects not only in the goals it pursues, but also in the structure and definition of it phases, the relationship between phases and the participants in each phase (Ballard and Howell 2003). Hence, applying the tools from lean construction in the construction project in order to innovate, requires collective adaption to the changed requirements and working methods from all stakeholders in the production system. Acknowledging that the production system and the project management needs to be structured and based on different techniques than traditional projects when innovating the construction processes, new tools and frameworks have emerged and influenced the industry, most prominently the Lean Project Delivery System (LPDS) (Ballard and Howell 2003). Thus, process innovation through implementation of principles drawn from lean construction entails a new project setting for the production system.

3.6 Theoretical Relevance of the Thesis

The literature review revealed that the complex and fragmented environment of the construction industry, as well as the interdependencies between the construction project participants, complicates the innovation efforts in the construction industry. Previous literature claims that the client is the most effective initiator of driving innovation in the industry. Traditionally, researchers have focused on the clients' ability to use learning and knowledge sharing when promoting innovations, while the effect of using concrete tools and methods have received little attention. Based on the findings of the literature review, there seems to be limited research and and a lack of theoretical understanding regarding the use of procurement systems as tools to facilitate innovation in the construction industry. Best practices have not emerged from practical and theoretical investigations, making the field open for further research and empirical investigations. In order to contribute to filling this theoretical gap, we will investigate the client's role of driving process innovations by using procurement systems as a tool.

4. Research Design and Methodology

4.1 Scientific Approach

Traditionally, researchers distinguish between two different viewpoints for the role of theory in research; inductivism and deductivism. These could be seen as
opposites. A deductive approach is concerned with developing a hypothesis based on existing theory, and then designing a research strategy to test the hypothesis (Wilson 2010). With an inductive stance, the connection is reversed; theory is the outcome of research. In an inductive approach the researcher aims on drawing generalizable inferences from observations (Bryman and Bell 2011). Approaches that involves weaving back and forth between research and theory is regarded as iterative (Bryman and Bell 2011). Systematic combining is an iterative approach that is positioned closer to an inductive viewpoint than a deductive viewpoint and is a process method where the theoretical framework, empirical work, and analysis of the case evolve simultaneously (Dubois and Gadde 2002b). As we plan to study the phenomena in light of a theoretical framework and our research will be based on a continuous interplay between established theory and our empirical research, we find the systematic combining method suitable for our research quest. Additionally, this approach will allow us to contribute to the theoretical understanding of what drives process innovation in the construction industry by refining and develop new theories based on our findings.

4.2 Qualitative vs. Quantitative

It is useful to classify business research methods into two different clusters; quantitative and qualitative. These strategies refer to how the researcher chooses to analyze and work with the information that has been gathered from the research subject (Bryman and Bell 2011). Quantitative research can be construed as a research strategy that emphasizes quantification in the collection and analysis of data. Qualitative research, however, can be construed as a research strategy that usually emphasizes words rather than quantification in the collection and analysis of data (Bryman and Bell 2011). Since qualitative research aims at understanding rather than explaining, we consider it to be a suitable strategy for our research.

4.3 Research Design: Case study with Supplementary Expert Interviews

Yin (2009, 23) states that a case study is appropriate when an “empirical inquiry must examine a contemporary phenomenon in its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident”. A case study also provides unique means of developing theory by utilizing in-depth insights of empirical phenomena and their contexts (Dubois and Gadde 2002b). In addition, expert interviews involve industry experts sharing knowledge and viewpoints on the the research issue. Belting (2008, 5) defines an
expert as a “person who has a high degree of skill and knowledge in a certain domain, field or industry due to long-time experience and has status, power-to-act and decision-making opportunities based on these skills and knowledge”.

Conducting a case study combined with expert interviews supports a detailed and intensive analysis on what drives the process innovation in the construction of KHiB. The opportunity to study the full complexity of a single case will enable us to reveal some interesting aspects regarding our research question, which had not been possible to expose if the scope were broader. In addition, supplementing our case study with expert interviews from actors in the industry that are not a part of the KHiB-project, will provide different viewpoints and foster a more nuanced and enriched investigation in a broader context.

We find the construction of KHiB a suitable case to illuminate interesting aspects regarding our research question due to several reasons. First of all, KHiB is the first extensive construction project where the client has implemented and enforced the contractors to work according to lean principles in the planning and construction process. Hence, the case is considered to be unique and open for empirical research. Secondly, applying lean principles affects everyone involved in the construction project and all actors will be affected by the innovation effort. This allows us to investigate the process innovation from different perspectives. Thirdly, the case also represents a situation where the innovation effort made is driven by the client, making the case open for elaboration on the client's responsibility and role in driving the innovation. Fourthly, the client has for the first time introduced lean experience/knowledge in the tendering foundation as a method to enforce innovation in the project, which makes it interesting to investigate how procurement methods can contribute in making innovation a collective act. Finally, as the KHiB-project is owned and performed by the industry leader and a role model in the Norwegian construction industry, the findings from the research will have a potential of influencing the industry in general. The supplementary expert interviews will allow us to investigate how third party actors in the industry considers and responds to the process innovation implemented in the KHiB-project and thereby broaden the scope of our research.

4.4 Data Collection

Doing a case study of an organization and to study it extensively will not provide any data by itself (Bryman and Bell 2011). The researchers have to decide upon a
suitable research method to use in the case study, and to reflect upon the types of instruments or techniques to be used for collecting the data. We have decided to carry out a qualitative research as we are seeking results that provide detailed insight into the individuals’ experience and interpretation of a situation based on words. The qualitative data collection can be divided into primary and secondary data, both by looking at external and internal sources of information (Jacobsen 2005). The data in this research will be both external and internal, and mostly primary. We have decided to triangulate between different types of data collection methods in order to ensure the research credibility.

4.4.1 Primary data

Primary data is data collected for the first time by the researcher. Examples of primary data are interviews, focus groups, and observations (Jacobsen 2005). As our research seeks to discover what drives process innovation in the construction industry, it will be efficient to carry out interviews with different stakeholders of the KHiB-project and key industry third-party participants in the aim to understand the situation from different perspectives. Performing interviews will contribute to the research by providing rich and detailed answers to the analysis.

*Interviews*

Semi-structured interviews that are adapted to each interviewee-cluster are preferred in this study, since the participants from the client organization and the contractor organizations have different roles in the innovation implementation in the project. To enable a broad in-depth understanding of the situation from the two perspectives, some flexibility is necessary, but the semi-structured interview guide will have the same base to ensure comparability of the different answers. Compared to a structured interview technique, a semi-structured approach will make the study more open to reveal new aspects that may steer our research in a new direction (Bryman and Bell 2011). This is in line with the iterative approach we base our study on. We aim at only perform one interview with each interviewee. However, as our study develop, elements that did not seem essential at the beginning of the study might have a crucial impact on the research, thus it might be necessary to perform some additional interviews with some interviewees.
**KHiB Interviewees:**

The main part of the case study will involve interviewing key stakeholders in the KHiB-project:

*Project manager and innovation initiator(s):* Since the process innovation in the project is client-driven, it will be beneficial to interview the project initiator to identify the main drivers behind the innovation efforts in this project and get the manager rationale behind the way the lean principles were implemented.

*Project owner:* Interviewing the project owner can provide important insight on how the client perceive their role in and responsibility to drive innovation in the construction industry.

*Client project participants:* A revolutionary tool to ensure innovation in the KHiB-project is the introduction of lean-criteria in the tender foundation. An interview with the person(s) responsible for designing the tender, will enable us to get an impression of the motivation behind the selection criteria, the impact of the criteria in tendering round and their own perception of the tools’ effect and success in a retrospect. Additionally, it would be beneficial for our study to interview the person(s) in the KHiB-project responsible for the contractors in order to get an understanding of the challenges and success regarding the contractor's adaptation and responsiveness to the innovation efforts.

*Contractors:* We intend to interview all the contracted contractors in the KHiB-project to explore in-depth how the contractors react to the innovation efforts made and requirements set by the client in this project, how they perceive their own role in driving innovation in the construction industry, and their viewpoint on the lean criteria in the tendering process. As the contractors have varying experience with the lean way of working and different attitudes towards innovation embedded in the organizational culture, the interviewees can potentially provide us with different viewpoints that will enrich our research. It will also be valuable interviewing the contractors that participated in the tendering process, to get their reaction on the innovation effort driven by the client and investigate whether the changed requirements set by the client result in them enhancing their lean knowledge to be competitive in the future.

*Consultants:* Consultants that advises the KHiB-project administration on different aspects in the construction process. For instance, RIBs can provide us with important viewpoints, as they understand the full complexity of the case, but at the same time has not possessed decision authority in the project.
Experts Interviewees:
Interviewing persons that do not directly take part in the KHiB-project, will provide different viewpoints and foster a more nuanced and enriched investigation on the issue in a broader context. We aim at interviewing different stakeholders in the construction industry, that all inhabits knowledge and opinions regarding process innovation in the industry.

Academia/R&D associations: Interviewing persons from academia and R&D associations can contribute in positioning the innovation effort made in the KHiB-project in relation to findings and practices that have emerged from prior research and provide theoretical reflection around the issue. These can be seen as “innovation brokers” by introducing new innovations to the industry.

Industry participants and professional associations: Getting input from key industry participants can illuminate how the innovation effort is perceived by the industry. Due to the client's position as a role model in the industry, it will be interesting to get an insight of how the network around are responding to the changes made. Professional associations like the Lean Construction Network, can provide valuable insight if the KHiB-projects implementation of lean principles is in line with the evolvement in the rest of the industry.

Participation and Attendance:
In order to enhance our overall understanding of the underlying mechanisms in the construction industry and the field of lean construction, the researchers have actively worked towards engaging in the industry. One of the researchers did an internship in the KHiB-project during the summer of 2015 and thereby gained working experience from the case company. Working closely together with the project staff provided valuable insight on how the project is organized in practice, the issues they are facing and the clients take on lean construction. The other researcher inhabits a position as an administrative assistant in the network association “Lean Construction Norway”. By attending network seminars and workshops, and by engaging in formal and informal conversation with key industry participants, the researcher gets exposed to different viewpoints, current issues and hot topics within the field of lean construction.
4.4.2 Secondary Data

Secondary data is data collected originally by someone else than the researcher (Bryman and Bell 2011). The collection of secondary data will in this research mainly be internal project documents that describes the construction process in the KHiB-project and documents from the tendering process. Documents from the tendering process includes the official tender documents, tender offers from the contractors and the internal tender evaluation documents used in the contracting of the contractors and will be a source in the analysis of the methods used by the client in the procurement systems to force and ensure, and thereby drive process innovation. Secondary data can also be used to analyze the prior innovation efforts in the client and contractor organizations, in addition to previous cooperation and contracts between the client and contractors. This historical data can help us to get a broader understanding of the rationale behind the innovation initiative.

4.5 Scientific Quality

It is important to ensure that the research is conducted in a way that secures high scientific credibility. Bryman and Bell (2011) defines reliability, replication and validity as the three most prominent criteria for the evaluation of business and management research. However, many scholars find it difficult to apply these concepts to the practice of qualitative research, due to their grounding in quantitative research. They propose that alternative terms and adaption in the way we assess qualitative research is required. Consequently, when evaluating the scientific credibility of our research we apply Lincoln and Guba’s (1985) criteria trustworthiness and authenticity, because we are under the perception that it will give a better assessment of the quality of our research since it is qualitative in nature and measurement is not a major preoccupation in our study.

4.5.1 Trustworthiness

Trustworthiness can be divided into four different criteria, each of which has an equivalent criterion in quantitative research; credibility, transferability, dependability and conformability (Bryman and Bell 2011).

To ensure high credibility, we aim to apply the respondent validation and triangulation technique. Triangulation entails using more than one method our source of data in the study of a phenomena (Bryman and Bell 2011). As we intend to base our research on case study interviews, expert interviews, participation, and
documents, this will increase our understanding of the complex phenomenon we are studying and thereby strengthen our research credibility. To ensure that there is a good correspondence between our findings and the perspective and experiences of our research participants, we intend to seek validation from all the different stakeholders contributing to our research.

*Transferability* relates to whether or not the findings are related to another context, or even the same context at some other time. Although we recognize that the construction industry is in constant revision and that our study is highly contextual, we argue that the intensive in-depth analysis our study aims at providing will be valuable to others. Due to the fact that KHiB is the largest project where lean principles has been implemented both in the planning and construction phase in the Norway and the contractors are enforced to conform to the new requirements, we argue that our findings will be transferable since they provide better basis for discussion of the best practices to drive and implement process innovation in the Norwegian construction industry.

Lincoln and Guba (1985) propose the idea of *dependability*, and argue that researchers should adopt an “auditing” approach. This approach entails ensuring that complete records are kept of all phases of the research process and that the researchers make use of peers as auditors to validate that the proper procedures are and have been followed. Our research will be closely monitored by our mentor in Statsbygg, which to some extent will have the role as an auditor. The KHiB-project staff has allowed us to operate with full transparency regarding our findings, hence it is possible to keep complete records of our research.

*Conformability* involves ensuring that the researcher has not allowed personal values or theoretical inclinations manifestly to sway the conduct of the research and findings deriving from it (Bryman and Bell 2011). Because we are collaborating with the client in conducting our research and one of the researchers did an internship at the company during the summer holiday, we find the issue of conformability, especially with regards to our distance to the research, something we need to be very conscious about. We intend to discuss this issue with our supervisor at BI to make sure our research is not blinded by our own perceptions of the circumstances. In addition, we need to acknowledge that the all participants we interview might not be able to provide us with a neutral or objective view on the situation, especially since the lean methodology is variously understood in the industry in general.
4.5.2 Authenticity

Lincoln and Guba (1985) introduce authenticity as a set of issues concerning the wider political impact of the research. The term is made up by fairness and ontological-, educative-, catalytic-, tactical- authenticity. We claim that our research is fair, since we intend to interview a variety of stakeholders, both from the client and contractor side, in addition to independent experts that represent different viewpoints and inhabits different perceptions regarding our research. Additionally, we believe that our research has the potential of receiving high educative- and ontological authenticity, as the research aims at providing both the client and the contractors with a better understanding of their social milieu.

5. Ethical Considerations

Bryman and Bell (2011) discuss the different types of ethical issues one needs to consider when carrying out a research. Several principles a researcher needs to take into account are accordingly introduced. The four main principles are: deception, harm to participants, lack of informed consent, and privacy invasion (Bryman and Bell 2011). We consider the possibility of our research violating these principles as minimal, since our aim is a research process based on full transparency, collaboration and openness. The KHiB-project staff is following our research closely and are functioning as a mentor; hence an opportunity for deception is not present. In addition to this, we have been granted full access to documents and interviewees and all research participants wish to shed light on the issue accurately. Therefore, there are no incentives for lack of privacy invasion, lack of informed consent and harm to the participants.

6. Project Plan

The project plan presented is tentative and we are open for changes.

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**APPENDIX**

**Appendix 1: Organization chart KHiB**

Source: Internal Documents, Statsbygg

**Appendix 2: A model of construction innovation process**

Source: Winch 1998